COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

Peter W. Schmidt
Director

MAY 31, 1995

P. O. Box 10009
Richmond, Virginia 23240-0009
(804) 762-4000

MR. JERRY REDDER, P.E.
ENVIRONMENTAL ENGINEER
ALLIANT TECH SYSTEMS
P.O. BOX 1
RADFORD, VA 24141-0100

RE: Correction Page - DEQ Review dated May 26, 1995

Dear Mr. Redder:

I am sending you a revised page for the Department's review of Radford's Ground Water Monitoring Program for the Incinerator Spray Pond dated May 26, 1995. The text the first paragraph of that review incorrectly referred to "the Battery Acid Treatment Pit at Building 2021 - Engineering Proving Ground" (Fort Belvoir) instead of Radford's Incinerator Spray Pond. Please replace the incorrect page with the revised page provided.

I apologize for any inconvenience that this error might have caused. Please call me at 804-527-5124 if you have any questions or comments.

Sincerely,

Glenn von Gonten

Glenn von Gonten
Geologist Senior

Attachment (1)

cc: Joe Wilson, RAAP
John Humphries, EPA
Norm Auldridge, DEQ
Howard Freeland, DEQ
Debra Miller, DEQ
Clifton Parker, DEQ
Leslie Romanchik, DEQ

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MAY 26, 1995

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MR. JERRY REDDER, P.E.
ENVIRONMENTAL ENGINEER
ALLIANT TECH SYSTEMS
P.O. BOX 1
RADFORD, VA 24141-0100

RE: Radford Army Ammunition Plant - Incinerator Spray Pond (HWMU 39) - Closure Groundwater Monitoring Plan
Radford Army Ammunition Plant, Radford, Virginia
EPA ID#: VA1210020730

Dear Mr. Redder:

The Department has completed it's first review of Radford Army Ammunition Plant's (RAAP's) proposed Detection Ground Water Monitoring Program (GWMP, the plan) for the Incinerator Spray Pond (HWMU 39). Thank you for submitting this plan. The Department has reviewed the plan and has determined that several deficiencies must be addressed before the plan can be approved.

Minor revisions to RAAP's proposed Ground Water Monitoring Program are denoted by redline/strikeout in quotes. The Department has provided RAAP with additional comments and guidance for sections requiring more substantial revisions. RAAP's plan generally does not supply sufficient detail to enable the technical reviewer to determine whether the required performance standards can be achieved.

COMMENT 1. Please revise the first paragraph on page 1 to indicate that "The groundwater monitoring program was designed in accordance with the ... (SW-846), Third Edition, to meet the performance standards specified for a Detection Ground Water Monitoring Program pursuant to VHWMR § 9.5.

COMMENT 2. Please revise the first paragraph on page by deleting the following sentences: ~~"Accompanying plans would be the RAAP Sampling and Analysis Plan and the Groundwater Quality Assessment Plan. The two RAAP plans will be revised to incorporate this new groundwater site as required."~~

CLOSURE, CONTINGENT CLOSURE AND CONTINGENT POST-CLOSURE PLANS FOR RADFORD ARMY AMMUNITION PLANT'S

INCINERATOR SPRAY POND (HWMU-39) RADFORD

RADFORD, VIRGINIA
EPA ID VA1210020730

RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA
EPA ID VA1210020730
~~May 16, 1995~~

DRAFT

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

Office of Waste Resource Management

Peter W. Schmidt
Director

P. O. Box 10009
Richmond, Virginia 23240-00(
(804) 762-4000

May 16, 1995

Mr. Joe D. Wilson, Chief Engineer
Department of the Army
Radford Army Ammunition Plant
Caller Service 2
Radford, Virginia 24141-0298

SUBJECT: Incinerator Spray Pond (HWMU-39) Closure Plan
Radford Army Ammunition Plant (Radford), Radford, Virginia
EPA ID# VA12100207306

Dear Mr. Wilson:

A revised closure plan for the Incinerator Spray Pond was sent on February 10, 1995, for Radford's review and comment. The Department requested a response date within 30 days, and Radford requested a 30 day extension on March 6, 1995, which was granted. Although Jerry Redder and the Department staff have discussed and made changes to the closure plan via faxes and telephone conversations during the review period, a written response is required, and the response period for Radford ended on April 5, 1995. Please have a Radford Army Ammunition Plant representative contact myself at the Virginia Department of Environmental Quality, in writing, within 10 days of receipt of this letter with additional comments or acceptance of the Incinerator Spray Pond Closure Plan as modified. If there is no written response from Radford within 10 days, the Department will assume that the closure plan is acceptable to Radford as revised, and ready for final review and approval. A revised version of the closure plan which takes into account all changes discussed between Radford and the Department so far is attached for your information and convenience.

Although, the Department cannot approve of the closure plan for the Incinerator Spray Pond without an approved groundwater monitoring plan, (which is in the review stage), it is desired to finalize the closure plan document as much as possible, pending groundwater plan approval.

If there are any questions about this, please do not hesitate to contact me at (804) 527-5107.

Sincerely,

Clifton L. Parker IV
Environmental Engineer Senior

Attachment

cc: Jerome J. Redder, P.E., Hercules Incorporated
Mary Beck, EPA Region III
Glen von Gonten, VDEQ
Lisa Ellis, VDEQ
West Central Regional Office - Roanoke
File

ALLIANT TECHSYSTEMS

Alliant Techsystems Inc.
Radford Army Ammunition Plant
Route 114
P.O. Box 1
Radford, VA 24141-0100

July 14, 1995

95-815-272

Clifton L. Parker IV
Department of Environmental Quality
Office of Permitting Management, Hazardous Waste
629 East Main Street, Suite 406
Richmond, VA 23219

Subject: Incinerator Spray Pond (HWMU-39) Closure Plan

Reference: DEQ Letter dated June 22, 1995

Dear Mr. Parker:

Enclosed is a paper copy and a "zipped" disk of the Incinerator Spray Pond Closure Plan for your review. This plan incorporates the comments in the referenced correspondence. We disagree with your response to Comment 4 of the referenced correspondence, concerning the handling of unregulated stones, concrete chunks, and boulders. However, in this specific case this ruling will not greatly affect the cost of disposal and the material will be placed in a permitted debris landfill if, after testing, it is not a hazardous waste. The revised Groundwater Monitoring Plan was delivered Mr. Glenn von Gonten July 5, 1995.

Please continue to direct your comments and questions on this topic to Jerry Redder, Alliant Techsystems Environmental Engineer, (703) 639-7536.

Very truly yours,

Jerry J. Redder

for C. A. Jake
Environmental Manager

Enclosure

JJRedder:gps

c: (w/o Attachment)
[redacted]on III
Hassan Vakili, VDEQ
Glen von Gonten, VDEQ
Lisa Ellis, VDEQ
West Central Regional Office- Roanoke

TABLE OF CONTENTS

Table 1

Closure Schedule

Activity	Days
Closure plan approved	
Interim activities to obtain Army funding -Cost estimate -Scope of work -Legal review	Up to 90 days
Receive funding from Army	0
Take background soil samples	10
Submit background soil sample results to DEQ	30
Remove and decontaminate piping, pumps, concrete, etc.	60
Take soil samples	70
Receipt of laboratory analyses Statistical evaluation	90
Remove contaminated soil/resample*	100
Receipt of laboratory analyses* Statistical evaluation	120
Equipment decontamination	130
Receipt of laboratory analysis of pre- and post-rinses and statistical evaluation	150
Inspection and remedial action	160
Certification of closure	180

* These steps will be repeated until clean closure is achieved, or until it is determined that clean closure cannot be achieved and the unit will close as a landfill.

FIGURES

TABLES

LIST OF ACRONYMS

CEI Comprehensive Evaluation Inspection
CFR Code of Federal Regulations
CHESNAVFACENGCOM Chesapeake Division, Naval Facilities Engineering Command
CQA Construction Quality Assurance
EEA Explosive Experimental Area
EPA Environmental Protection Agency
FFCA Federal Facility Compliance Agreement
GWMP Groundwater Monitoring Plans
HCOC Hazardous Constituents of Concern
MDL Method Detection Limit
NAVSWCDL Naval Surface Warfare Center - Dahlgren, Virginia
ND Not Detectable
NPL National Priority List
PQL Practical Quantitation Limit
PVC Polyvinyl Chloride
QA/QC Quality Assurance/Quality Control
RAAP Radford Army Ammunition Plant
RCRA Resource Conservation and Recovery Act
RDT&E Research, Development, Test and Evaluation
RFDs Reference Doses
RSDs Risk Specific Doses
RFI RCRA Facility Investigation
SCS Soil Conservation Service
SPLT Synthetic Precipitation Leach Test
VDEQ Virginia Department of Environmental Quality
VPDES Virginia Pollutant Discharge Elimination System Permit
VHWMR Virginia Hazardous Waste Management Regulations
WWTP Wastewater Treatment Plant

1.0 INTRODUCTION

1.1 Purpose of Study

The following closure plan is submitted in accordance with the requirements of the Commonwealth of Virginia's Hazardous Waste Management Regulations (VHWMR), Section 9.6.L. The plan identifies the necessary steps to close the incinerator spray pond (surface impoundment) located at the Radford Army Ammunition Plant in Radford, Virginia (Radford; EPA ID No.VA1210020730).

Questions regarding this report should be submitted to:

Mr. Joe D. Wilson
Chief Engineer
US Department of the Army
Radford Army Ammunition Plant
Caller Service 2
Radford, Virginia 24141-0298

Information about this report can also be obtained from Mr. Robert L. Richardson at (703) 639-8641, or Jerome J. Redder, P.E. at (703) 639-7536.

1.2 Background

The facility has operated a hazardous waste management facility subject to regulations promulgated under the Resource Conservation and Recovery Act. The Army is the owner of the Radford Army Ammunition Plant (Radford), located in Radford, Virginia and operated by Alliant Tech Systems (Alliant) which was the then existing Hercules Incorporated (Hercules). A Notification of Hazardous Waste Activity was filed for Radford with the EPA on August 14, 1980, declaring Radford to be engaged in the generation, treatment, storage, and disposal of hazardous waste under Title 40, Code of Federal Regulations, Part 261.

Since 1979, Radford operated a spray pond for the collection of incinerator scrubber waste waters. The wastewater was then reused as scrubber water for the incinerator. In August 1990, the Army and Hercules discovered that the scrubber waters collected in the spray pond had been contaminated with lead from the incineration process to the level that sludges which formed in the spray pond met the standards for a characteristic hazardous waste under Part III of the Virginia Hazardous Waste Management Regulations (VHWMR).

The Army and Hercules notified the Department of Waste Management (VDMW), [predecessor of the Department of Environmental Quality], of the contamination by letters of August 2 and 9, 1990. Subsequent discussions between the Army, Hercules, and VDWM resulted in the installation of a liner and the imposition of operational controls for the spray pond to prevent the introduction of further contamination and the agitation of the scrubber water in the spray pond to prevent hazardous waste sludges from forming.

By letter dated March 3, 1992, the Army and Hercules informed the Director of VDWM and the Director of the then existing State Water Control Board that sludges contaminated with lead meeting the levels of toxicity required for classification as a characteristic hazardous waste under Part III of the VHWMR were accumulating in the spray pond.

Neither the Army or Hercules has applied for or been granted interim status or a permit for the operation of the incinerator spray pond as a hazardous waste surface impoundment. Therefore, the Army owns and Hercules operates a hazardous waste surface impoundment without interim status or a permit to do so, in violation of applicable provisions of Parts IX, X, and XI of the VHWMR.

Thus, the incinerator spray pond which had begun operation in 1979 ceased operations in May 1992. An enforcement order ("order") was signed by the Department of Environmental Quality, the US Army, and Hercules which became effective on June 22, 1993. A Schedule of Compliance contained in the order required submission and implementation of a closure plan.

2.0 FACILITY DESCRIPTION

2.1 Site Location

The Radford Army Ammunition Plant (Radford or RAAP) is a government owned industrial complex located in southwestern Virginia. The Radford Army Ammunition Plant encompasses approximately 4,104 acres and is located in Pulaski and Montgomery Counties. The facility is located approximately 5 miles northeast of the city of Radford, 10 miles west of Blacksburg, and 47 miles southwest of Roanoke, (see figures 2-1, 2-2, 2-3, 2-4, 2-5, 2-6). The New River separates Pulaski and Montgomery Counties and also divides the RAAP into two portions commonly known as the "Horseshoe Area" and the "Main Manufacturing Area." The "main manufacturing area" of Radford is located south of the New River meander in Montgomery County, and the "Horseshoe Area" of Radford is located within the New River meander in Pulaski County. The incinerator spray pond unit is located in the "Horseshoe Area", the north west area, Pulaski County. Table 2-1 summarizes the propellants which are manufactured at the facility.

2.2 Incinerator Spray Pond Description

The spray pond is a concrete-lined impoundment which is rectangular with dimensions of 76 x 60 x 5 feet deep. The maximum water level is three feet deep for a maximum volume of 13,680 cubic feet or 102,340 gallons. There are perforated pipes in the spray pond which were used to try to prevent sludges from forming by blowing air and creating turbulence in the water which must be removed and decontaminated. Currently there is rain water in the impoundment. The sludge and liquids which precipitated the sludge formation have been removed. The lead content of the water and the sludge in the spray pond has at times been above 5 ppm, which resulted in the hazardous waste surface impoundment designation.

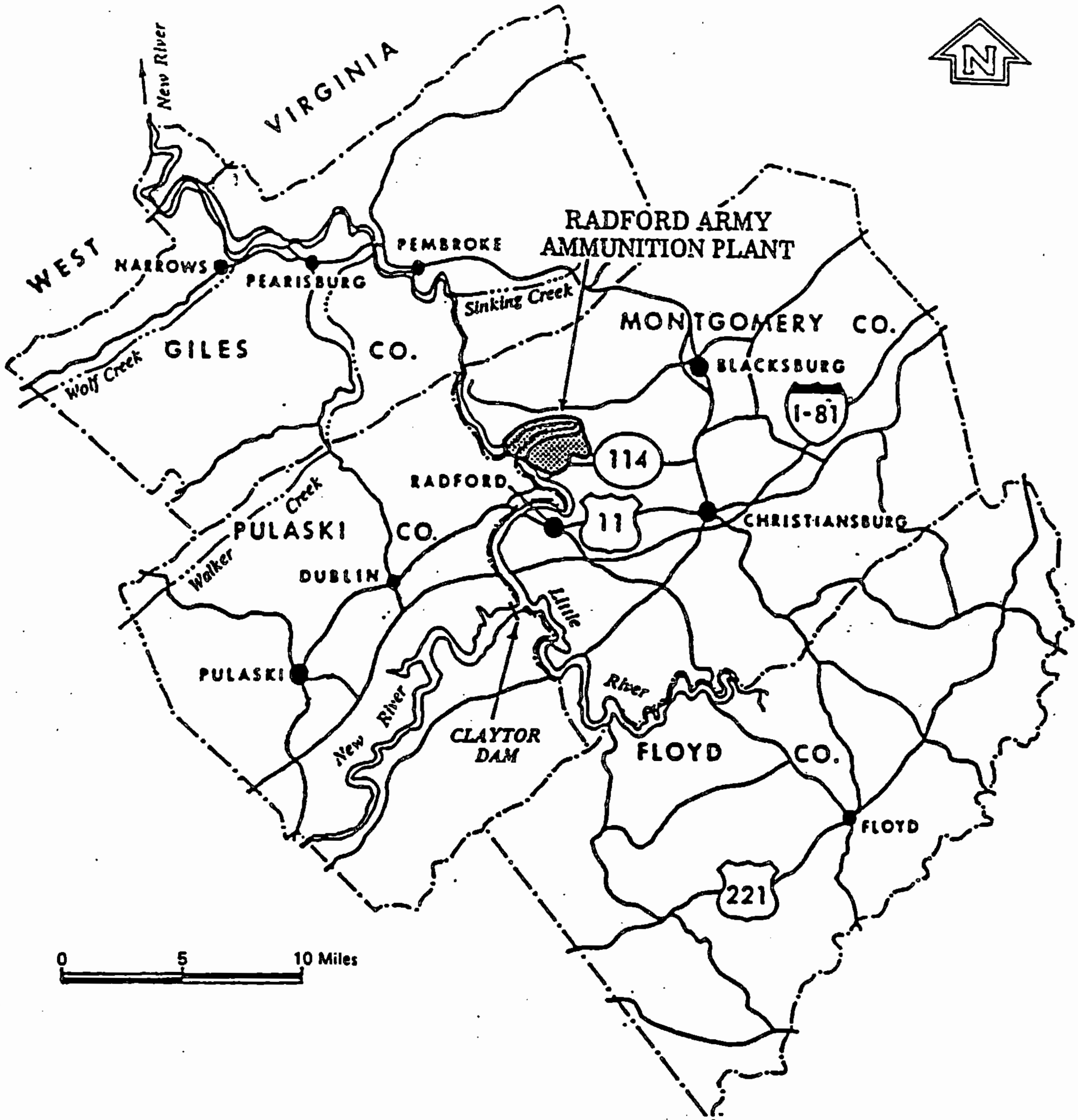


FIGURE 2-1 VICINITY MAP

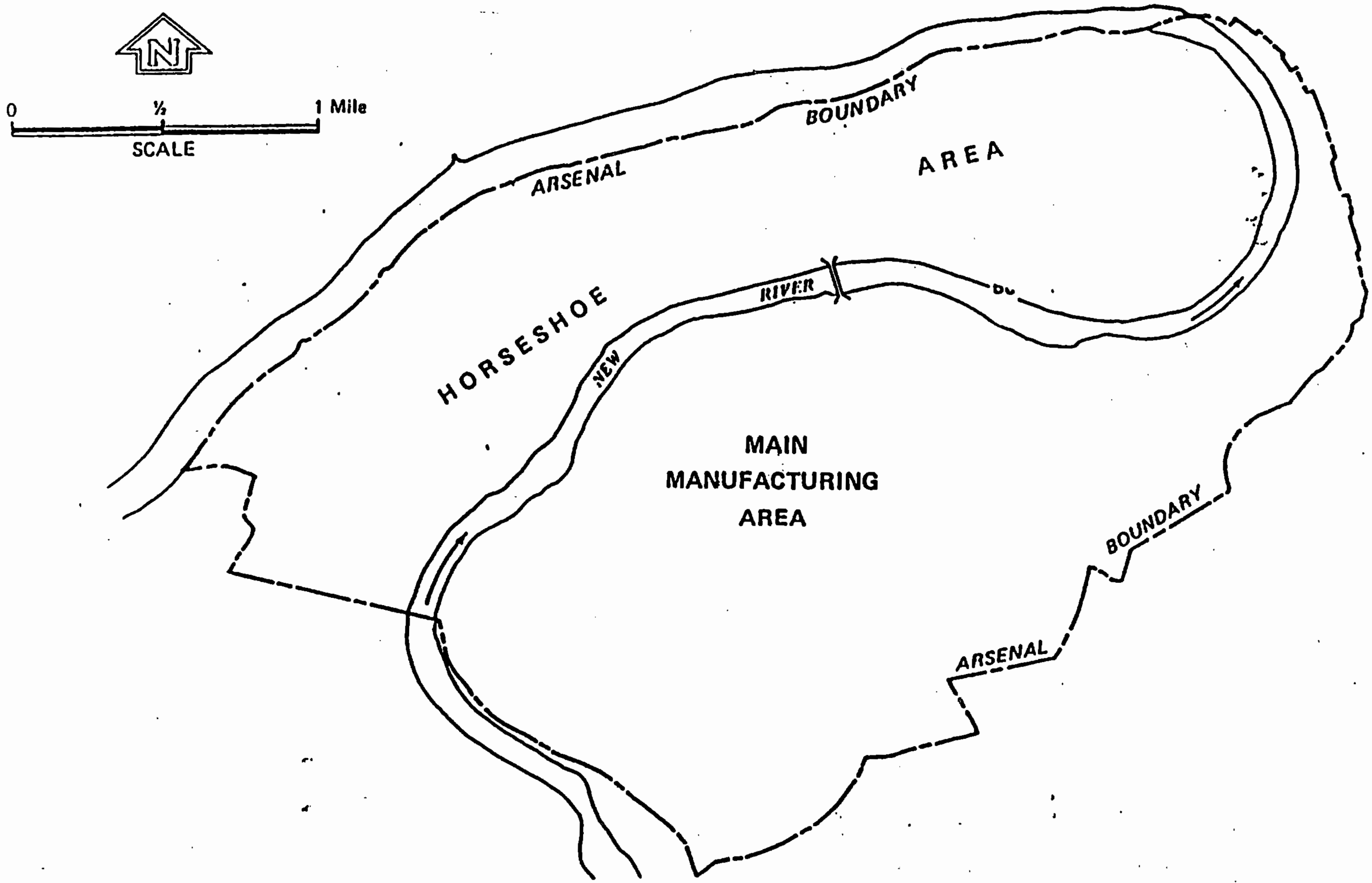


FIGURE 2-2 SITE BOUNDARY

Approximate Boundary of the Radford Army Ammunition Plant Hazardous Waste Management Facility

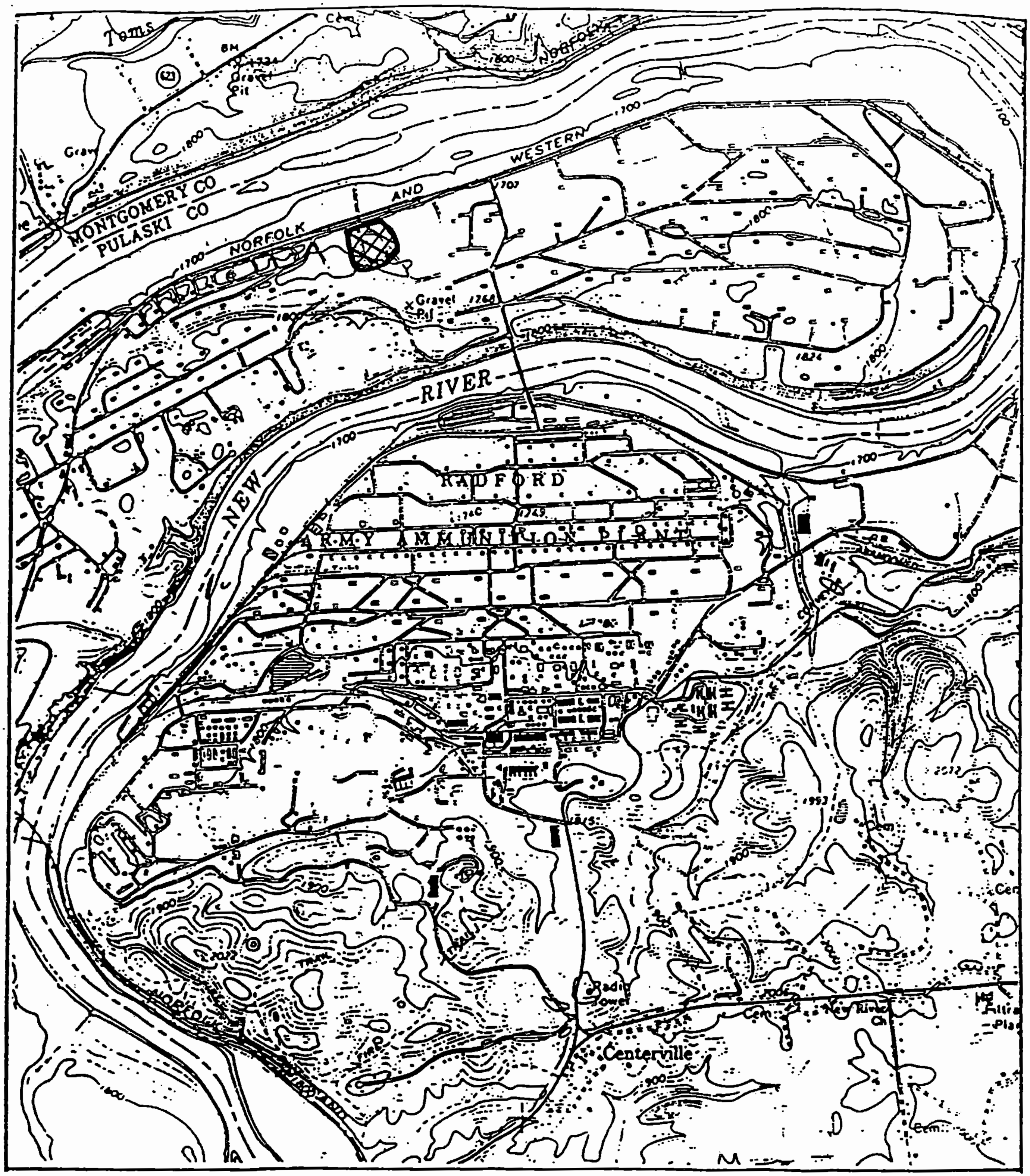


FIGURE 2-3 TOPOGRAPHIC MAP

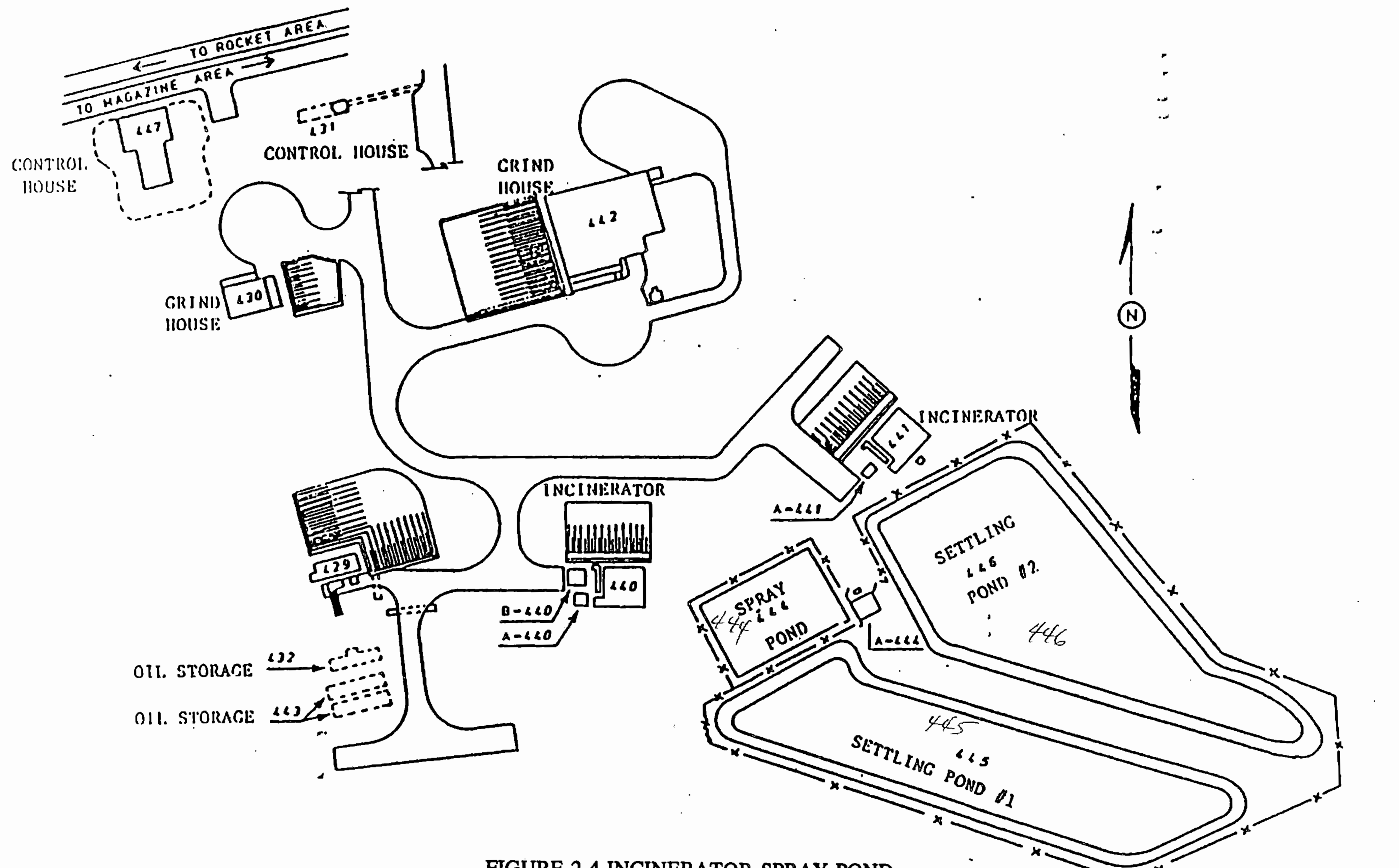


FIGURE 2-4 INCINERATOR SPRAY POND

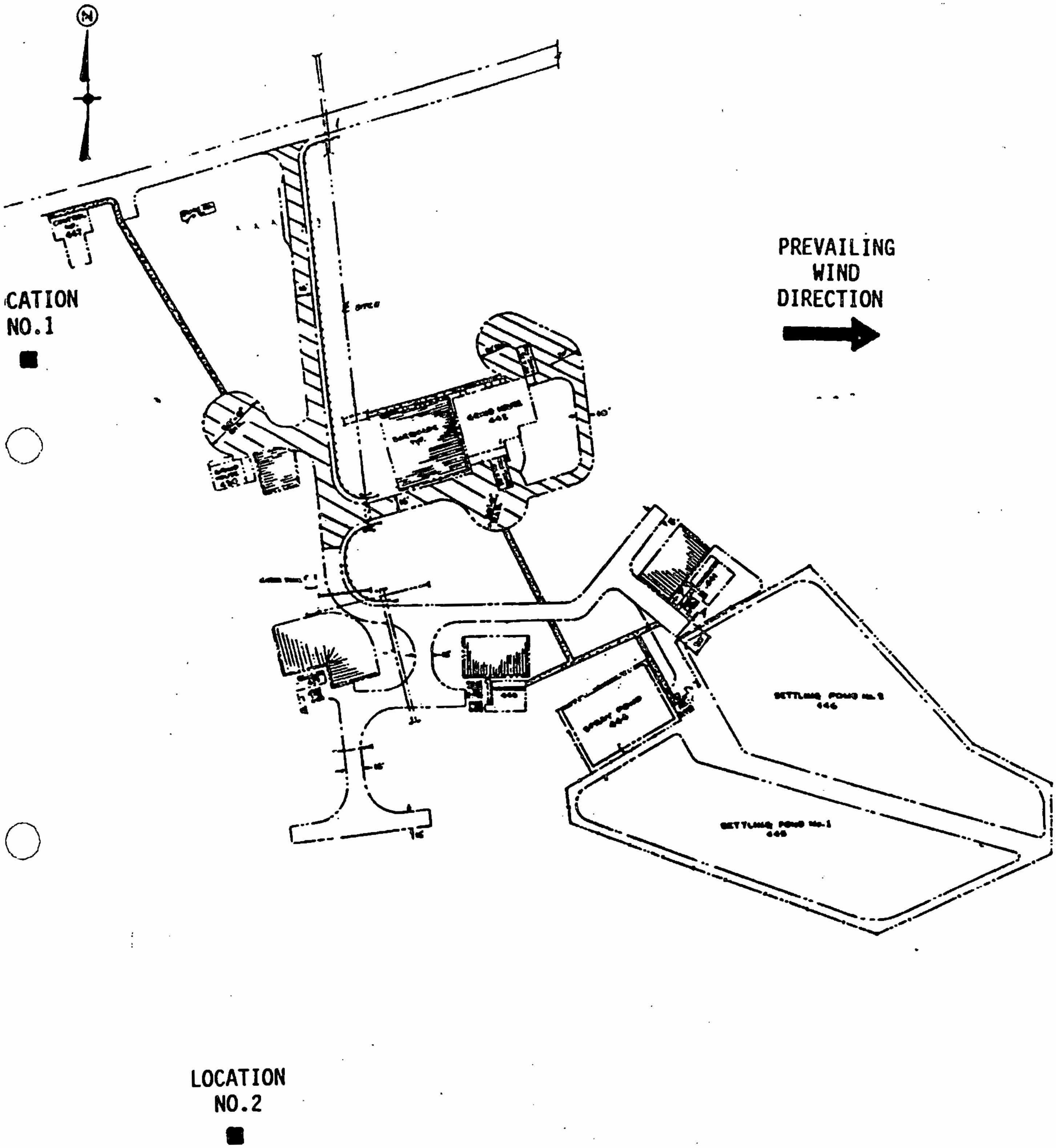
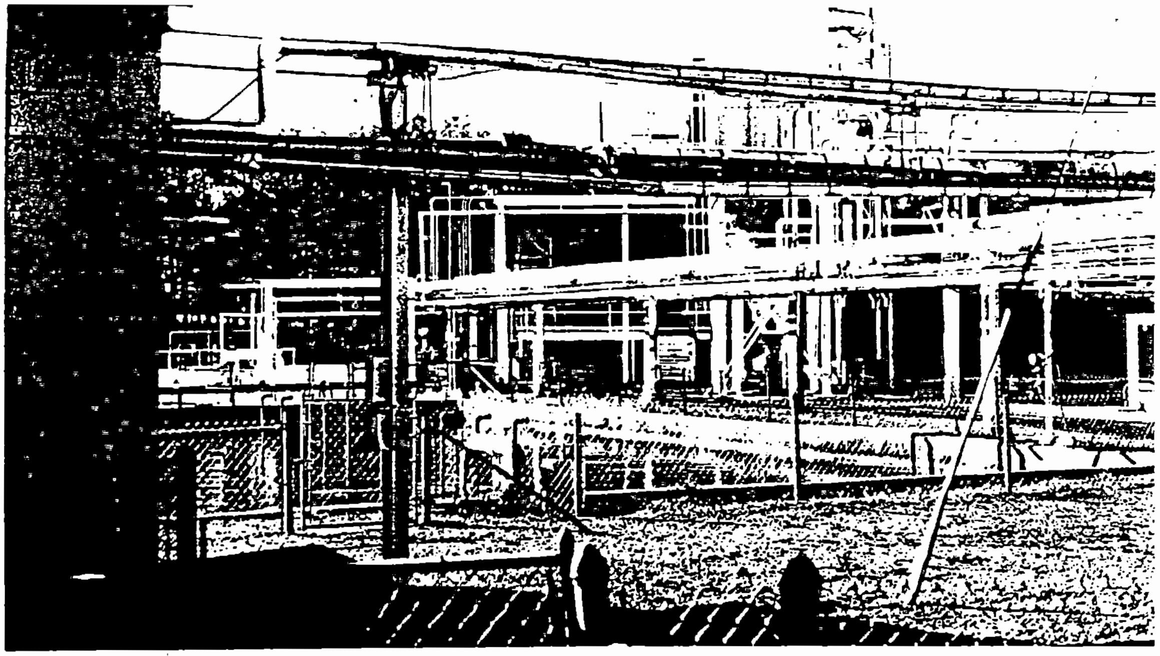


FIGURE 2-5 TWO PROPOSED BACKGROUND SAMPLING LOCATIONS



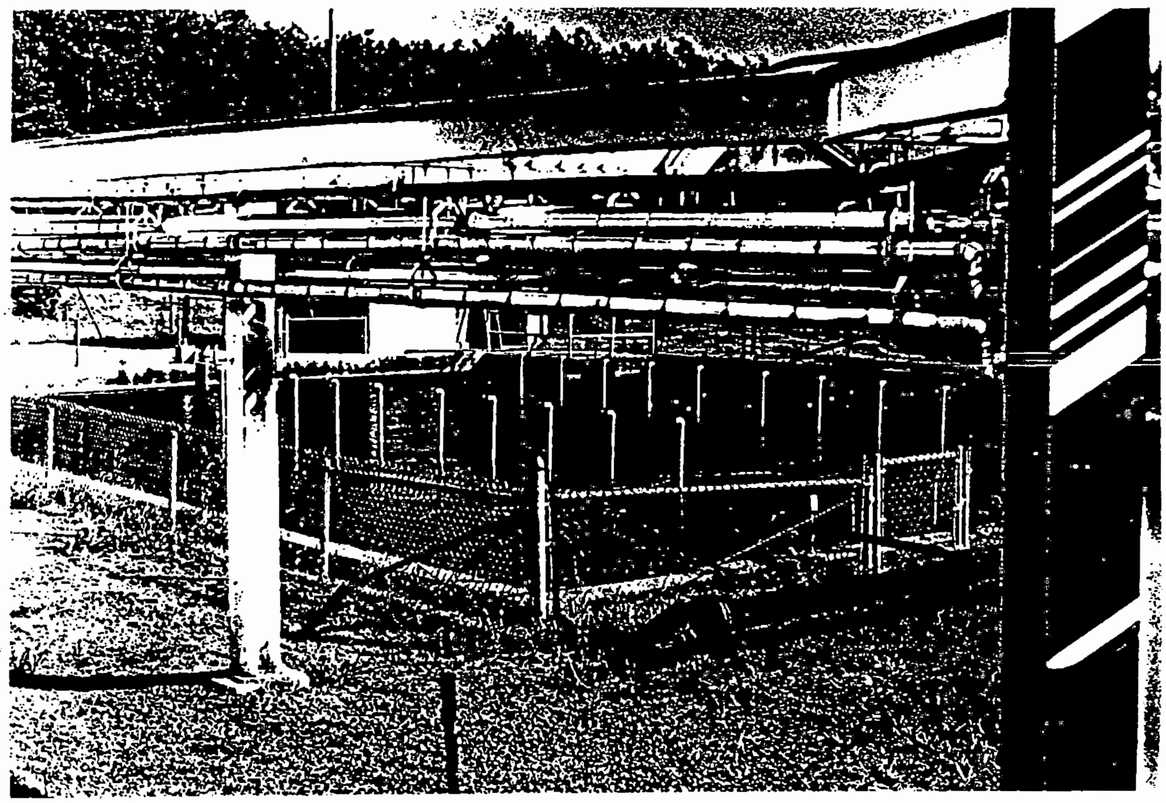


FIGURE 2-6 INCINERATOR SPRAY POND PICTURES

PROPELLANTS MANUFACTURED BY RAAP

Categories of Propellant	Number of Propellants Manufactured	Major Chemical Constituent(s)	Weight Percent	Organic Solvents used in the Production of Solvent-Propellants
o Single-base propellants	15	nitrocellulose	40-100	diethyl ether ethyl alcohol
o Double-base propellants	31	nitrocellulose nitroglycerin	25-84 10-45	ethyl alcohol acetone
o Triple-base propellants	4	nitrocellulose nitroglycerin nitroguanidine	19-29 18-24 45-55	ethyl alcohol acetone
o Cast and extruded propellants	3	nitrocellulose nitroglycerin	49-54 31-37	nitroglycerin triacetine
o Miscellaneous	4	nitrocellulose nitroglycerin acetone propylene glycol dinitrate	0-65 0-16 0-59 0-77	acetone

Source: RCRA Part B Permit Application

TABLE 2-1 PROPELLANTS MANUFACTURED BY RADFORD

2.3 Facility Background

Although Radford is owned by the US Government, it has been operated under contract by Hercules Aerospace Corporation since 1941. This facility, which contains over 1,696 buildings and occupies close to 3,649,965 square feet, is the top manufacturer of solid propellants in the United States. The major products manufactured at this facility are solvent and solventless propellants that include single phase (nitrocellulose), double-phase (nitrocellulose and nitroglycerin), and triple phase (nitrocellulose, nitroglycerin, and nitroguanidine) propellants; cast propellants; and high energy propellants. These propellants are ultimately used in small arms, anti-tank weapons, anti-aircraft weapons, rockets, torpedoes, missile systems, igniters, and other numerous ordnance-related items.

2.4 Incinerator Background

The Army and Hercules have been manufacturing explosives and rocket propellants at the facility since 1941. In 1979 two incinerators were completed and the incineration of waste and off-specification explosives and propellants began. These incineration operations became regulated subsequent to the promulgation of the federal hazardous waste regulations under RCRA in 1980. On November 15, 1980, the facility submitted Part A of the RCRA permit application and was granted "interim status" by the United States Environmental Protection Agency on November 30, 1981. On December 3, 1984, the facility submitted Part B of the RCRA permit application. After several reviews and revisions of the Part B application, a final permit was issued by the Virginia Department of Waste Management on November 9, 1989.

On December 7, 1989, the Army and Hercules filed a Notice of Appeal of the final permit. The primary basis of the appeal was the claim that operating conditions in the permit, specifically the minimum kiln operating temperature, were not reasonable. On January 31, 1990, the Director of the Department of Waste Management granted a stay of the Department's November 9, 1989, decision issuing the permit. On July 23, 1990, the Department of Waste Management, the Army, and Hercules entered into a compliance agreement. This agreement continued the stay of the November 9, 1989, permit and required the Army and Hercules to conduct a new trial burn in order to re-establish incinerator operating parameters. In April 1993, the facility conducted a trial burn and on July 10, 1993, the facility submitted a trial burn report as required by the compliance agreement. The DEQ Waste Division, reviewed the new trial burn report and found it to be complete and adequate. Pursuant to VHWMR § 11.19., the DEQ simultaneously revoked the November 9, 1989, permit and issued a new permit. The incinerator spray pond is no longer used in conjunction with the incinerators.

2.5 Type of Wastes Managed at the Facility

The major products of manufacture at the RAAP are explosives and rocket propellants. There are five major categories of propellants produced at the facility. These categories are:

- Single base propellants (primary constituent nitrocellulose);
- Double base propellants (primary constituents nitrocellulose and nitroglycerine);
- Triple base propellants (primary constituents nitrocellulose, nitroglycerine, and nitroguanidine);
- Cast and extruded propellants; and
- Miscellaneous items

"Off-specification" propellants which do not meet Army production standards and "NG slums" are the waste materials which are treated and incinerated at the facility. NG slums are generated from cleanup of nitroglycerine (NG) in the production process and contain nitroglycerine, sawdust (to absorb the liquid), and triacetin (to desensitize the NG).

All of the waste materials described above are regulated as hazardous waste by virtue of the fact that they exhibit the hazardous characteristic of reactivity pursuant to VHWMR § 3.8.

Hazardous wastes incinerated at the facility may contain hazardous constituents as specified VHWMR Appendix 3.6. Such constituents include:

- Dinitrotoluene
- Nitroglycerine
- 2,4 and 2,6 Dinitrotoluene
- Dibutylphthalate
- Diethylphthalate
- Resorcinol
- Antimony
- Arsenic

- Barium
- Beryllium
- Cadmium
- Chromium
- Lead
- Mercury
- Silver
- Thallium

During the April 1993 trial burn, the facility demonstrated adequate destruction and removal efficiency (DRE) for these constituents. In addition, the maximum content of these constituents fed to the incinerator, and maximum emissions of the constituents from the incinerator are specified in the incinerator permit.

2.6 Waste Management Operations at the Facility

Hazardous waste from manufacturing operations at the facility is placed into containers at the point of generation. These containers are transferred to the facility hazardous waste accumulation area where they are held until they are transferred to the permitted treatment area.

At the permitted treatment area, the solid materials are ground and then mixed with water to form a slurry. The slurry is then pumped from the tank to one of two incinerators. Each incinerator system has a rotary kiln incinerator followed by an afterburner, a gas cooler, a fabric filter, a liquid scrubber, an exhaust draft fan, and a 35 foot exhaust stack.

The rotary kiln incinerators are natural gas fired units manufactured by Bartlett-Snow. Waste slurry is fed into the burner end of the kilns. The inclined rotating kilns create a tumbling action which allows the liquid portion of the slurry to boil off and the remaining solids to be burned.

The afterburners, gas coolers, fabric filters, liquid scrubbers, draft fans, and exhaust stacks comprise the air pollution control systems (APCS). The afterburners are also natural gas fired and they serve to combust any unburned gases evolved from the primary kiln. The gas coolers are wet systems utilizing water to cool the exhaust gas from the afterburners. The fabric filter is a series of Gore-Tex bags designed to capture particulate matter in the gas stream. The scrubbers are wet scrubbers with hydro filters designed to further cool the exhaust gases and dissolve or precipitate vapors in the gas stream.

Operating conditions for the kilns and APCS are specified in the incinerator permit. Should any of the monitored parameters vary beyond the prescribed operational limits, the waste feed to the incinerator will automatically shut off. Waste feed will not resume until operating conditions are again within the specified limits.

2.7 Scrubber Description

The scrubber is installed at the exhaust from the explosive waste incinerator. The scrubber water contacts the incinerator exhaust gases which exchange heat and dissolve contaminants from the hot incinerator gas. Currently, the scrubber water does not flow to the spray pond, but stays in a tank and is part of the incinerator's operating permit. Previously, the scrubber water was pumped back to the spray pond where evaporative cooling took place. Water in the spray pond was re-used until the sludges which formed in the spray pond met the standards for a characteristic hazardous waste under Part III of the VHWMR. The spray pond contained varying amounts of lead at any time depending on the quantity of lead containing propellant incinerated. Traces of other heavy metals have also been detected in the spray pond water, although not at high enough concentrations to be a toxic hazardous waste.

Currently, the incinerator process has been modified so that the scrubber currently evaporates to the atmosphere while lead and other metals are deposited into a dust hopper after the water is evaporated, with no excess scrubber water which could contain leaded sludges.

3.0 CLOSURE PLAN

3.1 Introduction

The following closure plan for the incinerator spray pond has been prepared to meet the requirements of VHWMR Sections 9.6.L, 10.6 and 10.10.I.

3.2 Closure Performance Standards (VHWMR Section 10.6.B)

The following paragraphs describe the closure plans for the incinerator spray pond. These plans are intended to provide for closure of these units in a manner that will:

- Minimize the need for further maintenance, and
- Control, minimize or eliminate, to the extent necessary to prevent threats to human health and the environment, post-closure escape of hazardous waste, hazardous waste constituents, leachate, contaminated rainfall, or waste decomposition products to the ground or surface waters or to the atmosphere.

The closure performance standards will be accomplished by (1) the removal of the pond's contents; (2) removal or decontamination of any contaminated liner components, as well as aeration piping, ancillary piping, and pumps; (3) the sampling, testing, analysis, and possible removal of contaminated subsoils; and (4) assess groundwater contamination by implementation of the approved groundwater management plan. Sampling of the subsoils to show that constituent levels are no higher than background concentration will be the demonstration for clean closure. If subsoils cannot feasibly be shown to have less than or equal to background levels of constituents statistically, then the facility can attempt a clean closure by use of health based standards. The facility retains the option at any time to not attempt clean closure and to close as a landfill as delineated in § 9.13., VHWMR Amendment 13.

3.3 General Closure Approach

The free liquid in the ponds was drained to the minimum pump intake level during operation of the incinerator leaving approximately 6 inches of liquids and sludge on the floor of the pond shortly after the enforcement order became effective. The remaining water and sludge was removed and properly disposed of according to the VHWMR by transporting the waste residues to a permitted RCRA hazardous waste disposal facility by a permitted hazardous waste transporter. The hazardous waste manifest forms are on file with VDEQ. The spray pond has subsequently been inactive and has filled with rainwater.

The water in the ponds will be analyzed for all hazardous constituents of concern identified in this document for Radford's hazardous waste generation reporting requirements, and the liquids will be sent to the waste water treatment plant via the adjacent forcemain. The pond's concrete liner will be demolished. Any bedding material under the concrete will be removed. Pumps and ancillary piping will be removed and decontaminated. Soil sampling and testing will identify sub-soils to be removed for disposal. Testing of the subsoils will be performed to confirm that the closure performance standards have been met. Once any contamination has been removed, the excavation will be back-filled with clean soils, graded to promote positive drainage, and re-vegetated. Equipment will be decontaminated in an approved manner. The contaminated materials (i.e. possibly soils, sludges, concrete, pipes, pumps and equipment rinsate) will be transported to a permitted RCRA hazardous waste disposal facility by a permitted hazardous waste transporter.

3.4 Inventory of Wastes (VHWMR § 10.6.C.2.c)

The inventory of wastes includes both a description of the amount of waste as well as its characteristics.

3.4.1 Maximum Waste Inventory

An estimate of the maximum waste inventory for the incinerator spray pond is shown in Table 3-1.

TABLE 3-1 MAXIMUM WASTE INVENTORY	
Waste Type	Quantity
liquid/sludge	76' x 60' x 3' = 13,680 cf = 102,336 gallons

3.4.2 Waste Characterization

The spray pond was used to cool scrubber water by evaporation. The water contacted the incineration exhaust to cool the hot gas and precipitate and dissolve contaminants. Heavy solids settled to the bottom of the spray pond and formed a layer of sludge beneath the liquid. The sludge was determined to be toxic for lead (>5 ppm), or EPA Hazardous Waste code D008.

3.5 Cleanup Targets

The development of cleanup targets is a two step process. First the hazardous constituents of concern (HCOCs) are identified. In this case, the incinerator's permit has identified certain VHWMR, Appendix 3.6 constituents be considered as potential hazardous constituents of concern. Appropriate cleanup levels are then developed for the constituents.

Target levels for cleanup will be developed by analyzing the background samples for the constituents of concern using the analysis methods outlined in Table 3-2. Using the analysis results, the tolerance limits for a normal distribution are calculated with 95% coverage and a 95% confidence. Analysis results for each constituent of concern for the pond will be compared to the upper tolerance limit. If the constituent level in the unit exceeds the upper tolerance limit for the background, the soil will be considered contaminated, and will be removed from the site. Disposal will be in accordance with VHWMR and VSWMR using analytical results from the wastes.

3.5.1 Hazardous Constituents of Concern

Hazardous constituents of concern are defined as those materials which may have come into contact with the unit during its lifetime. Hazardous constituents of concern for this closure are based on a review of off-specification product incinerated at Radford from the incinerator's operating permit. The following table 3-2 lists the hazardous constituents for this closure. The associated analysis methods and detection limits are also provided.

TABLE 3-2 HAZARDOUS CONSTITUENTS OF CONCERN

Contaminant	SW-846 Method	PQL Water (μg/L)	PQL Soil (μg/Kg)
2,4-Dinitrotoluene	8090	0.2	13
2,6 Dinitrotoluene	8090	0.1	7
Dibutylphthalate	8060	3.6	240

Diethylphthalate	8060	4.9	330
2,4-Dinitrotoluene	8090	0.2	13
2,6-Dinitrotoluene	8090	0.1	7
Resorcinol	8270	100	_
Antimony	7041	30	30
Arsenic	7060	10	10
Barium	6010A	20	20
Beryllium	7091	2	2
Cadmium	7131	1	1
Chromium	7191	10	10
Lead	7421	10	10 µg/kg ppb
Mercury	7470 or 7471	2	2
Nickel	6010A	150	150
Silver	7761	2	2
Thallium	7841	10	10

Note: - = Not determined, Method 8270 may be used. The detection limit must be consistent with the detection limit of other constituents using this method, and documented through the QA/QC.

3.5.2 Development of Cleanup Targets

Closure to background levels will constitute soil's clean closure. Background levels will be determined from soil samples collected in areas that have not been affected by the operation of the incinerator spray pond. Background soil samples will be collected in an area with a depositional environment similar to the sediments underlying the incinerator spray pond, i.e., same approximate depth, color, odor, etc.

Background soil samples will be collected from selected locations in uncontaminated areas near and around the incinerator spray pond. By distributing the sample collection points within a geographic area with similar underlying sediments, the background sampling group will not be unduly influenced by any unknown local "hot spots".

how many? randomness?

3.6 Procedures for Removing, Transporting, Treating and Disposing of Wastes from the Incinerator Spray Pond (VHWMR Sections 10.6.C.2.c, 10.6.C.2.d and 10.10.I.1.a)

VHWMR Section 10.10.I.1.a requires that all sludge and other contaminated components of the pond (i.e. piping, concrete, bedding material, subsurface soils, etc.) be removed or decontaminated for surface impoundment soils to be "clean closed". To meet these requirements, Radford will remove all contaminated materials.

3.6.1 Incinerator Spray Pond Dewatering

The free liquid in the ponds was drained to the minimum pump intake level during operation of the incinerator leaving approximately 6 inches of liquids and sludge on the floor of the pond (prior to this closure plan's approval). The remaining water and sludge was removed and properly disposed of according to the VHWMR by transporting the waste residues to a permitted RCRA hazardous waste disposal facility by a permitted hazardous waste transporter. The hazardous waste manifest forms for the transport of the waste are on file with VDEQ.

The spray pond has subsequently been inactive and has filled with rainwater. The water in the ponds will be tested for hazardous characteristics for the facility's waste generation/record keeping purposes, and the liquids will be sent to the waste water treatment plant via the adjacent forcemain. When the ponds' free liquid has drained, a visual inspection will inspect for any remaining or newly formed sludge. If sludge is found, it will be tested for hazardous characteristics and handled in accordance with the VHWMR. All hazardous waste generator requirements of VHWMR Parts V and VI will be followed. It is expected that no solids will have formed since the pond has not been in use since it was thoroughly cleaned.

3.6.2 Concrete Liner and Bedding Material Removal

The concrete liner will be demolished. One representative sample of the concrete will be taken and tested for hazardous characteristics in accord with VHWMR Part III. If the concrete tests positive for a hazardous characteristic, then the concrete liner will be transported by a permitted hazardous waste transporter to a RCRA approved hazardous waste treatment, storage, or disposal facility. All hazardous waste generator requirements of VHWMR Parts V and VI will be followed. If the concrete liner representative sample tests negative for hazardous characteristics, then the concrete will be disposed of in a permitted debris landfill.

A sand and gravel bedding material may exist under the concrete liner. One representative sample of the bedding material will be taken and tested for hazardous characteristics. If the bedding material tests positive for a hazardous characteristic, then the bedding material will be transported by a permitted hazardous waste transporter to a RCRA approved hazardous waste treatment, storage, or disposal facility. All hazardous waste generator requirements of VHWMR Parts V and VI will be followed. If the bedding material representative sample tests negative for hazardous characteristics, then the bedding material will be disposed of in a permitted debris landfill.

3.6.3 Pipes and Pump Removal

In cooperation with concrete demolition, the piping, drains, and pumps will be removed and decontaminated according to Section 3.8.3. Piping, valves, and pumps will be dismantled and placed in a washdown station. Decontaminated piping will be disposed of as scrap metal. If in good condition, decontaminated pumps, valves, and piping will be placed in storage for possible future use. Pipes, pumps, and valves which cannot be decontaminated will be transported to a permitted RCRA hazardous waste disposal facility by a permitted hazardous waste transporter. The materials will be transported by a permitted hazardous waste transporter to a RCRA approved hazardous waste treatment, storage, or disposal facility. All hazardous waste generator requirements of VHWMR Parts V and VI will be followed.

3.6.4 Subsoil Assessment

The investigation/assessment described herein will be implemented to determine whether residual hazardous waste constituents (as defined under the VHWMR) associated with the scrubber water leached into the underlying subsoils, and to determine if clean closure of the soils is achievable. If it appears achievable, Radford will excavate contaminated subsoils. The materials will be transported by a permitted hazardous waste transporter to a RCRA approved hazardous waste treatment, storage, or disposal facility. All hazardous waste generator requirements of VHWMR Parts V and VI will be followed.

The pond will be excavated as rapidly as possible to lessen the possibility of a precipitation event that may transport contaminants through the unsaturated zone. Radford will be responsible for scheduling and planning the excavation to limit the occurrence of this potential situation.

Data will be collected by performing the following tasks:

- Collect sufficient data to determine the horizontal and vertical extent of contamination in the subsoils.
- Collect sufficient data to calculate the quantities of affected subsoils.
- Statistically compare samples to representative background samples for designated closure parameters to evaluate achievement of clean closure.

3.7 Sampling and Analysis Plan

The following soil sampling and analysis plan details the necessary sampling procedures and analysis methods that will be employed to verify clean closure of the soils.

3.7.1 Background Sampling for Soil Assessment

Background conditions will be established as follows. Four background samples are the minimum number to achieve statistically useable background data. VDEQ recommends 6 to 8 background sampling locations for Radford's Incinerator Spray Pond Closure. It is Radford's option to select more than eight background sampling locations to provide variance in the statistical background. The sampling locations shall be in soil similar to the soil under the concrete spray pond liner. These background sample locations will be selected from an area of the plant reasonably assumed (based on general knowledge of the area and plant operations) to be uncontaminated by any industrial activities that could have resulted in past or present releases of hazardous constituents. Background soil sample results along with the quality assurance/quality control (QA/QC) documentation required by SW-846 will be submitted to the VDEQ prior to performing statistical comparisons for approval of background soil sample locations.

Standard statistical methods will be used to test assumptions of normality and to check for possible data outliers; techniques supported by the statistical literature will be used, and relevant references will be cited; (i.e, "Outliers in Statistical Data," V. Barnett and T. Lewis, 1984).

Any outlier data identified will either be:

- Replaced by data obtained in a subsequent supplemental background sampling effort;
- Replaced by the sample value closest to the outlier value (if no further supplemental background sampling is conducted); or
- If any other method(s) are identified to handle outliers, justification willbe provided for the use of the selected method(s).

Data transformations will be applied, as needed, to ensure that the key assumptions are met when computing interval estimates and/or conducting hypothesis tests. However, the analytical methods to be employed are robust (in the statistical sense), and will likely apply even if the underlying assumptions are not fully met.

The minimum number of valid background samples to be utilized is four. Radford Army Ammunition Plant reserves the option to take additional background samples for purposes of determining whether collected data are non-normal so that appropriate adjustments can be made.

Special handling will be required for samples with "not-detected" values as the analytical result. One-half of the corresponding lower detection limit value for the analytical method employed will generally be used as the numerical replacement for "not detected."

After an appropriate assessment of the background data is conducted and the data are formally approved by the VDEQ, a background critical value will then be calculated based on a one-sided upper tolerance limit.

With respect to the tolerance limit approach discussed below, many references can be cited, but the method and numbers quoted in this section come from Handbook 91, Experimental Statistics, United

States Department of Commerce, National Bureau of Standards, issued August 1, 1963. From this reference (specifically pages 2 through 14 subsection 2.5.3), the upper tolerance limit for a normal distribution is as follows:

$$X_{cv} = X_{ave} \pm (K)(s)$$

where, X_{cv} is the critical value computed for the one sided upper tolerance limit;

X_{ave} is the computed average of the background samples;

s is the computed standard deviation of the background samples; and,

K is a theoretically-determined value given in a table.

The parameter K (or $K_{95(.95,n)}$) establishes the upper tolerance limit such that there is a 95% chance that at least 95% of the time, the actual constituent background concentration will be below this upper bound. The value of this parameter for eight samples (n=8) is 3.188. To establish clean closure of the soil, the results of the analyses of each sample will be compared to the upper tolerance limit for the HCOCs. If the values for each HCOC are below the respective upper tolerance limit, then the sample has been demonstrated to be "clean."

The established statistical conditions are to be 95% confident that at least 99.75% of the background population can be expected to lie below the critical value, X_{cv}. Therefore, if a clean closure parameter observed in a spray pond soil sample yields a value that exceeds X_{cv}, then it will be concluded that the soil (in the sample's representative location) is statistically greater from background and must be removed to establish clean closure of the soil.

3.7.2 Subsoil Testing

This section describes the specific assessment protocols to be utilized to determine if clean closure can be achieved for the incinerator spray pond subsoils. The methodology presented below is based on meeting the data requirements outlined. Figure 3-1 shows the 20 grid nodes developed based on the outlay of expansion joints. Since the joints in the concrete liner are the most likely sources of contamination, sampling locations will be selected based on the joint locations. The grid consists of 19x20 foot sections.

The plan described below was developed in accordance with sound standard statistical methods. All data obtained will be reviewed, summarized, and analyzed according to the methods described in this section. Statistical techniques used throughout the analysis will be clearly explained and will be supported by citing appropriate references. Full citations can be found in the References. The closure plan consists of the followings aspects:

- Background characterization
- Initial random sampling of the subsoils
- Possible excavation, repeat sampling, or contingent closure
- Repeat excavation and sampling or contingently close
- Supplemental "hot spot" delineation sampling of the subsoils (if required)

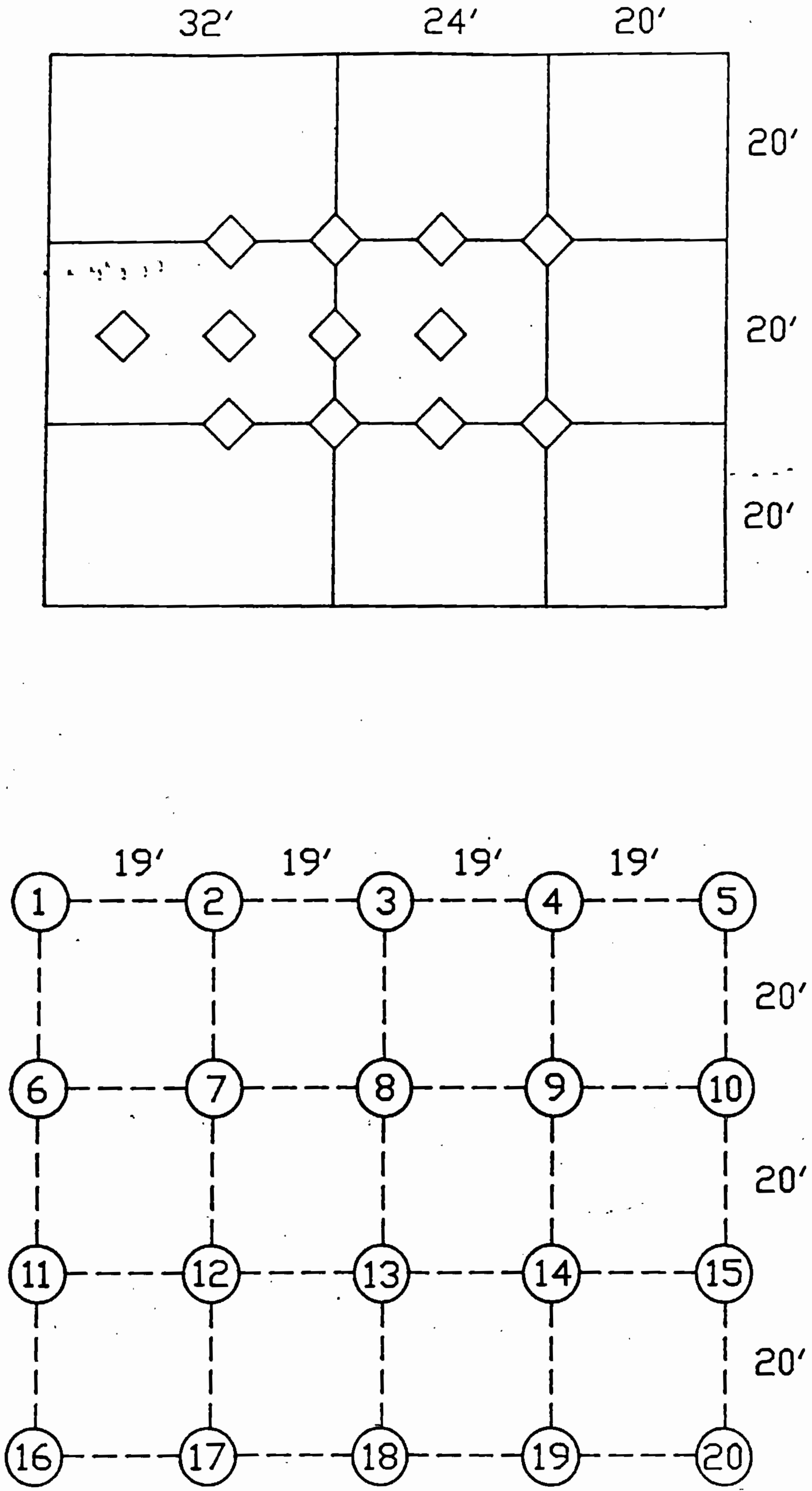


FIGURE 3-1 SAMPLING GRID AND NODES

The initial random sampling will be conducted to determine if clean closure can be achieved and whether soil removal will be required to achieve clean closure. A "hot spot" sampling approach may be used to better delineate contaminated areas for excavation and subsequent disposal, depending on the results from random sampling. The samples will be discrete samples.

Radford Army Ammunition Plant reserves the option, at any point during the incinerator spray pond subsoils assessment, to abandon attempts to demonstrate clean closure and immediately implement contingent closure and post-closure.

The subsoils will be evaluated by collecting a minimum of eight soil borings, randomly distributed across the grid nodes which intersect the expansion joints in the concrete liner, (or identified cracks). Samples will be collected at the surface (0-3 inches), 6 inches, 12 inches, 18 inches, and 24 inches. The samples will be analyzed by vertical stratum for the established hazardous constituents of concern. If analytical results of the surface samples are below cleanup goals, the unit will be considered clean and no additional sampling and analysis will be performed.

If the surface samples' analytical results are statistically above background levels, each successive set of samples (6 inches, 12 inches, 18 inches, 24 inches) will be analyzed until all sample analytes are statistically below the background levels of constituents. The subsoils will be excavated to the depth where all sample analytes are below the background levels.

Alternatively, Radford may choose to sample, test, and compare each one of the 20 sampling node locations. The nodes located as "hot spots" by this testing will then be excavated to a point where the sample analytes are below clean-up goals.

If random sampling indicates that contamination is widespread across the spray pond in a layer, then the layer may be excavated without performing additional sampling to reduce costs on sampling. On the other hand, if it appears that contamination is localized, more sampling and testing can be performed with the intention of reducing costs on excavating only the contaminated subsoils.

The excavation of "hot spot nodes" will be the 19'x20' grid surrounding the node, (or half way between the successive nodes.)

A sufficient number of samples will be analyzed to statistically confirm clean closure. Sample values will be compared to the upper tolerance limits as discussed in "Background Sampling". Data values reported as less than the Practical Quantitation Limit will be treated as one half (½) the Practical Quantitation Limit (PQL) unless the facility chooses another method in accordance with the methods outlined in Guidance on Statistical Methods for Groundwater Data Analysis at a Solid Waste or Hazardous Waste Site, Virginia Department of Environmental Quality, Office of Waste Resource Management, 1994, and by the procedures summarized in Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Interim Final Guidance (April, 1989).

If the samples taken at any level contain hazardous constituents of concern statistically above the background levels, a decision may be made to continue sampling and excavation or to implement the contingent closure plan. A determination of the appropriate point to discontinue excavation and begin implementation of the contingent closure plan will be based on actual field conditions encountered.

3.7.3 Initial Physical Observation of Subsoils and Excavation

Radford Army Ammunition Plant may observe physical signs of contamination including discoloration of subsoils, odor, or others. If physical signs of contamination are observed, Radford reserves the option to excavate potentially contaminated subsoils until the physical signs of contamination are no longer apparent prior to initial random sampling.

3.7.4 Initial Random Sampling and Excavation

The sample grid will be assembled by field personnel prior to sampling. Wooden stakes or other suitable material will be used to mark all points along the sample grid.

A minimum of eight soil borings, distributed randomly across the 20 grid nodes will be advanced to a depth of 24 inches. The eight nodes selected for sampling will be determined via use of a random number generator. All eight samples taken will be analyzed for each of the hazardous constituents of concern specified in this closure plan. Additional borings may be placed in areas of suspected contamination, such as an area where the liner was found to be cracked. Samples will be collected at the surface, 6 inches, 12 inches, 18 inches, and 24 inches.

In the event that the contaminated soils cannot be practically removed, then the contingent closure plan will be implemented. A determination of the appropriate point to discontinue excavation and begin implementation of the contingent closure plan will be based on actual field conditions encountered.

The surface samples will be collected using disposable stainless steel hand corers. A stainless steel auger will be used for collecting the 6, 12, 18, and 24 inch samples. The auger will be forced down into the soil and then withdrawn. The bottom of the six inch soil layer will be placed in the sample container. If the desired depth cannot be reached using the hand auger or if the soil is tightly packed, then a portable power auger will be used for sample collection. Soil sampling will be performed in accordance with the representative sampling methods contained in VHWMR Appendix 3.2.

For a particular clean closure parameter, if all of the individual random sample values are at or below the established critical value (X_{cv}), then the pond will be considered "clean" with respect to that clean closure parameter and no further sampling for that parameter will be required. However, if any of the individual lagoon random sample values for that clean closure parameter are above the critical value supplemental "hot spot" delineation sampling (discussed below) may be performed based on actual field conditions encountered.

3.7.5 "Hot Spot" Delineation Sampling and Excavation

Based on the results of the initial random sampling, supplemental "hot spot" delineation sampling will be conducted for all clean closure parameters. (However, as previously noted, Radford reserves the option at any point in the sampling process to abandon attempts to achieve clean closure and immediately implement the Contingent Closure and Post-Closure Plans.)

If implemented, the hot-spot delineation method will proceed as follows:

1. Additional sampling of the existing surface soil (0-6) inch layer will be conducted at the remaining (20-8=12) twelve grid nodes not previously sampled under the previous random sampling effort. These additional samples will be analyzed for all clean closure parameters for which clean closure was not confirmed under the previous random sampling effort.

2. For all 20 grid nodes sampled, independent comparisons will be made of each individual node sample value to the background critical value (X_{cv}).

3. If the background critical value (X_{cv}) is equal to or greater than the individual pond node sample value, that particular node is considered "clean" with respect to the closure parameter being evaluated. If, on the other hand, the background critical value (X_{cv}) is less than the node sample, then:

   a. Based on the results from surrounding sample location nodes, hot spot area(s) within the defined areal extent of the pond will be delineated for subsequent soil removal efforts.

   b. Additional subgrid sampling may be performed to further refine delineation of identified "hot spots" for soil excavation.

   c. After excavation of the existing surface soil (0-6 inch) layer within defined hot spot(s), resampling will be performed at all established grid nodes within the "hot spot" area(s). Samples will be analyzed for all clean closure parameters (HCOC's) for which clean closure has not been demonstrated.

d. Following resampling, comparison to background[1] along with additional 6-inch soil layer excavation (if required) will be performed in accordance with the protocols previously outlined.

If, upon following these protocols in an attempt to achieve clean closure, the pond surface soils have been removed from hot spot(s) down to a sufficient level without achievement of clean closure for all closure parameters, Radford Army Ammunition Plant will consult with VDEQ and either:

- Contingent closure and post-closure will be implemented in accordance with this plan.
- The protocols detailed above will continue to be extended to soil layers below.
- Discuss health based closure.

As previously stated, the facility reserves the option, at any point during the incinerator spray pond subsoils assessment, to abandon attempts to demonstrate clean closure and immediately implement contingent closure and post-closure.

3.8 Field Quality Control

To ensure the collection of representative samples, the following field quality control procedures will be utilized during the closure operations.

Equipment blanks will be collected after every 20th sample. If equipment blanks indicate contamination, then resampling will occur only if sample results are above cleanup levels. Samples will be analyzed for the hazardous constituents of concern identified in this document. Laboratory quality control will be according to the methods detailed in SW-846.

Laboratory quality control will be according to the methods detailed in SW-846.

[1](Optional) The background critical value described thus far will have been computed from the top layer (0-6 inches) of the background area. It may be necessary to sample background at lower intervals (6-12 inches, 12-24 inches) for comparison at lower intervals to avoid bias. This option should be implemented if, for example, distinctly different soil types are encountered at depth, thereby necessitating re-establishment of background.

3.8.1 Sample Preservation and Maximum Holding Times

Soil samples usually require no preservation other than storing at 4°C until analyzed. The maximum holding times vary for different measurements. Table 3-3 provides the maximum holding times for certain inorganic and organic analyses. Although these criteria were specifically designed and tested for water samples, they are also applicable for soil sampling studies (Barth and Mason, 1984).

TABLE 3-3 REQUIRED CONTAINERS AND MAXIMUM HOLDING TIMES FOR SOIL SAMPLES
(This table was adapted from Tables 2-16 and 4-1 of SW-846)

Name	Container	Maximum Holding Time
Inorganic Tests: Acidity	P,G	14 days
Alkalinity	P,G	14 days
Ammonia	P,G	28 days
Chemical Oxygen Demand	P	28 days
Cyanide, total and amenable to chlorination	P,G	14 days
Metals: Chromium VI	P,G	24 hours
Mercury	P,G	28 days
Metals, except chromium VI and mercury	P,G	6 months
Nitrate	P,G	48 hours
Nitrate-nitrite	P,G	28 days
Nitrite	P,G	48 hours
Oil and grease	G	28 days
Organic carbon	P,G	28 days
Orthophosphate	P,G	48 hours
Phenols	G only	28 days
Phosphorus (elemental)	G	48 hours
Phosphorus, total	P,G	28 days
Sulfate	P,G	28 days
Sulfide	P,G	7 days
Sulfite	P,G	Analyze immediately
Organic Tests: Volatile Organics	4 ounce, (120 ml) wide mouth glass with teflon liner	14 days

Semivolatile Organics/Organochlorine Pesticides/PCBs	8 ounce, wide mouth glass with teflon liner	Samples must be extracted within 1 days and extract analyzed within 4(days following extraction.

Notes: Soil samples collected for purgeable organic compounds analyses shall be thoroughly mixed and containerized as soon as possible after sampling. The samples shall be placed in the sample container so that no head space is left in the container after the container is closed.

3.8.2 Split Samples, Spiked Samples and Blanks

Blanks, split samples and spiked samples are collected to provide a measure of the internal consistency of the sample collection and handling methodology and to provide an estimate of the components of variance and the bias in the analytical process.

Samples can be split to:

- Provide a measure of the within sample variability.
- Provide material for spiking in order to test recovery.
- Provide a measure of the sample extraction error.

The component of variation that is measured by a split sample is determined by the location of the sample splitting. A field split measures errors associated with field handling and within sample variation. A split of samples made in the laboratory for extraction purposes measures the extraction error (Barth and Mason, 1984).

A true split of sediment, soil or sludge samples is almost impossible to accomplish under field conditions. The difficulty of splitting a sample increases as the sample's moisture content increases. The sample should be considered a duplicate sample, rather than a split sample (EPA Region IV, Standard Operating Procedures and Quality Assurance Manual, 1986).

Spike samples are made by adding a known amount of a reference chemical to one of a pair of split samples. The recovery of the analytical process is measured by comparing the analysis results of the spiked sample with the non-spiked sample. The difference in results provides a measure of the analytical bias.

Spike samples are difficult to prepare with soil material. Usually, the spike solution is added to the extract of the soil. Utilizing this procedure avoids the problem of mixing, etc., but does not provide a measure of the interaction of the chemicals in the soil with the spike nor does it provide an evaluation of the extraction efficiency. Due to these constraints, field spikes are not commonly used (Barth and Mason, 1984). <u>Field spikes will not be used in these investigations.</u>

Blanks are collected to provide measures of various cross-contamination sources, background levels in the reagents, decontamination efficiency and any other potential errors that can be introduced from sources other than the sample. The blanks associated with field QA/QC include the trip blank, field blank and equipment blank. A trip blank measures any contamination that may be introduced into the sample during shipment of containers from the laboratory to the field and back to the laboratory. A field blank measures input into the sample from contaminated air or dust. An equipment blank measures chemicals that may have been in the sample container or on the tools after equipment decontamination is complete.

EPA's Third Edition of Test Methods for Evaluating Solid Wastes, (SW-846) recommends that QA/QC samples be collected at least once with every analytical batch with a minimum of once per twenty samples. This sampling frequency has also been stated in the document Soil Sampling Quality Assurance Users Guide (Barth and Mason 1984).

Table 3-4 presents a breakdown of the recommended field QA/QC procedures for soil sampling. The contracting laboratory may desire to collect more QA/QC samples than detailed. Prior to sampling, Radford will consult with the contracting laboratory about the appropriate QA/QC procedures. These procedures will be in accordance with EPA's Third Edition of Test Methods for Evaluating Solid Waste (SW-846).

TABLE 3-4 FIELD QA/QC PROCEDURES FOR SOIL SAMPLES

PROCEDURE		COMMENTS
1.	Field Blank	Field blanks are metal-and/or organic free water aliquots that contact sampling equipment under field conditions and are analyzed to detect any contamination from sampling equipment, cross-contamination from previously collected samples, or contamination from conditions during sampling (i.e. airborne contaminants that are not from the waste being sampled). One sample of site tap water will be collected every day in which tap water is used for decontamination purposes.
2.	Duplicate Samples	Field duplicates are employed to document precision. The precision in sample duplicates is a function of the variance of waste composition, the variance of the sampling technique, and the variance of the analytical technique. Duplicate samples should be collected in the field by aliquotting a sample into separate containers. One duplicate sample will be collected for every twenty samples. The containers should be labeled as duplicate samples.
3.	Trip Blanks	Trip blanks are used to detect any contamination or cross-contamination during handling and transportation. Trip blanks should accompany sample containers to an from the field. The appropriate trip blank containers should be filled with analyte-free water. Preservations and additives will be added as required for each parameter group. Trip blanks should be sealed and stored in an ice chest where real samples will be stored and transported. A pair of trip blanks will accompany each cooler containing empty or filled volatile sample containers.

4.	Equipment Blanks	An equipment blank should be prepared for each parameter group sampled where a particular piece of sampling equipment was employed for sample collection and subsequently decontaminated in the field for use in additional sampling. The equipment blank should be composed in the field by collecting, in the appropriate container for the parameter group, a blank water rinse from the equipment (auger, pump tubing, etc.) after execution of the last step of the proper field decontamination protocol. Preservatives or additives must be added to the equipment blank where appropriate for each parameter group. The type and frequency of these samples are specified within the text discussing the extent of contamination sampling.
NOTES: 1) Reference: SW-846, Chapter Nine, Pages Nine 61-63; Chapter One Page 1-10. 2) Field QA/QC samples should be collected at least once with every analytical batch with a minimum of once per twenty samples.		

3.8.3 Sampling Equipment Decontamination

All non-disposable sampling equipment will be decontaminated between each sample. Those sampling implements which cannot be decontaminated effectively will be containerized and properly disposed of based on sample analytical results.

The decontamination of sampling equipment (hand auger, scooplula, trowel, etc.) will be performed as follows and follows the decontamination procedures for sampling equipment (EPA Region IV, Standard Operating Procedures and Quality Assurance Manual, 1986,):

1. Clean with tap water and a soap solution (A phosphate-free laboratory detergent such as Alconox, Aliquinox, Liquinox will be used for cleaning) using a brush if necessary to remove particulate and surface films.
2. Rinse thoroughly with the Radford's potable water.
3. Rinse thoroughly with deionized water.
4. Rinse thoroughly with organic-free water and allow to air dry as long as possible. If organic-free water is not available, allow equipment to air dry as long as possible. Do not rinse with distilled or deionized water.
5. Wrap with aluminum foil, if appropriate, to prevent contamination if equipment is going to be stored or transported.

All rinsate waters will be contained and analyzed for the constituents of concern prior to discharge. Disposal of rinsate will be performed based on sampling results and in accordance with the VHWMR. All sampling equipment will be decontaminated prior to sampling, between sample depths, and between samples unless new or dedicated (i.e, used only for one sample) equipment is used. Sampling equipment will be disposed of as hazardous waste at the conclusion of the sampling program, where appropriate.

Large equipment used for closure activities will be cleaned prior to its use on site. The decontamination of the larger sampling equipment will occur in a temporary constructed decontamination area. A 20-ft x 30-ft area will be graded with at least a 2% slope towards one corner of the area. The area will be lined with an appropriate plastic liner to prevent infiltration of decontamination water into the soils. The area will drain into a polyethylene container. Rinsate and other wastes generated during decontamination will be placed into 55 gallon drums. This proposed decontamination area has been designed so as not to meet the definition of a surface impoundment (40 CFR Part 260.10). Following closure, the large sampling equipment will be decontaminated using steam cleaning followed by a potable water rinse.

All wastes generated during the decontamination process will be accumulated in 55 gallon drums for less than 90 days storage.

The decontamination area's synthetic liner will be disposed of in accord with the VHWMR and the VSWMR. If analytical results show the liner is a hazardous waste by characteristic, then the liner will be transported via a Virginia permitted hazardous waste transporter and disposed of off-plant at an approved hazardous waste facility. if it is not hazardous, it will be disposed of in a permitted debris or sanitary landfill.

The rinsate collected during the decontamination process will be transferred to 55-gallon drums for storage until test results are received. If the water in the drums tests to be hazardous, it will be accumulated according to VHWMR, § 6.4.E., transported via a Virginia permitted hazardous waste transporter and disposed of off-plant at an approved hazardous waste facility. if it is not hazardous, it will be disposed of in the biological waste water treatment plant with VDEQ approval. Equipment blanks will be collected for decontamination quality control.

3.8.4 Sample Handling

Each sample jar should be clearly labeled with an identifying number, the point of sampling as documented on a diagram of the area, the time and date of sample collection, the name of the individual responsible for sample collection, and the parameters for analysis.

When the sample jars are shipped to the laboratory, a seal will be placed on the shipping container in such a way that the containers cannot be opened in transport without breaking the seal.

A chain-of-custody record will be maintained to document the responsibility for sample possession from the time of collection until the analysis is completed.

A field log book will be maintained. The sample location, the time, date, parameters for analysis, and approximate volume of each sample will be recorded. The appearance of the sample, the conditions at the time of sampling and any other relevant field observations will be recorded.

3.9 Sample Custody

3.9.1 Introduction

Sample identification and chain-of-custody establishes the documentation and control required to identify and trace a sample from collection to completion of analysis. Sample identification and chain-of-custody will be maintained during all closure activities conducted at Radford Army Ammunition Plant through the following chain-of-custody procedures and documentation:

- Sample labels, which prevent misidentification of samples;
- Custody seals to preserve the integrity of the sample from the time it is collected until it is opened in the laboratory;
- Field logbook and pictures to record information about closure activities and sample collection;
- Chain-of-custody record to establish the documentation necessary to trace sample possession from the time of collection to laboratory analysis; and
- Sample analysis request sheet to inform the laboratory of pertinent information noted in the field logbook.

The purpose of these procedures is to ensure that the quality of the sample is maintained during its collection, transportation, storage and analysis.

3.9.2 Chain-Of-Custody

A sample is in custody if it is (1) in someone's physical possession or view, (2) locked up, or (3) kept in a secure area that is restricted to authorized personnel.

3.9.3 Field Custody Procedures

As few persons as possible should handle samples in the field. The sample collector is personally responsible for the care and custody of samples collected until they are transferred to another person. The site team leader for the closure activities will determine whether proper custody procedures were followed during field work and decide if additional samples are required.

3.9.4 Sample Labels

Identification sample labels are to be attached to the field sample containers. Gummed paper labels or tags should be used. The tags should contain the following information:

1. Name of collector
2. Date and time of sample collection
3. RAAP-#39-XX-YY-ZZ

   where: RAAP = Site name (RAAP)

   #39 = Unit Number

   XX = Grid Location Number

   YY = Sample Depth (As depth below datum, i.e., bottom of concrete liner)

   ZZ = Special Code as follows:

   01-Normal Sample

   02-Duplicate Sample

   03-Field Blank

   04-Trip Blank
4. Type of sample with brief description (i.e., grab, composite, background, soil, liquid, concrete, bedding material; random, "hot spot", decontamination test, etc.)

Sample information will be printed on the label in a legible manner using waterproof ink. The identification on the label must be sufficient to enable cross reference with the laboratory logbook.

Sample labels will be affixed to the sample containers prior to or at the time of sampling. The labels will be filled out at the time of collection.

3.9.5 Custody Seals

Custody seals are reprinted adhesive-backed seals with security slots designed to break if the seals are disturbed. Seals are placed over the cap of the individual sample bottle and in as many places as possible on shipping containers. The seals will be affixed to the sample bottles and shipping containers before the samples and containers leave the custody of the sampling personnel. The custody seals will at a minimum contain the following information:

- Sample number (This number must be identical with the number on the sample label)
- Name of collector
- Date and time of sampling
- Place of collection

3.9.6 Field Logbook

Field logbooks are necessary to provide sufficient data to enable field participants to reconstruct events that occurred during the closure activities.

All pertinent sampling and field survey information will be recorded in a logbook. All logs will be kept in a waterproof bound notebook with numbered pages (8-1/2 by 11 inches). All entries will be printed in waterproof ink. No pages will be removed and corrections will be made by drawing a single line through the incorrect data and initializing and dating the correction that was made to the side of the error. Entries in the logbook should contain at a minimum the following information:

- Location of sampling point (and location code XX-YY-ZZ as stated above)
- Name and address of field contact
- Type of waste (i.e. soil, sludge, wastewater)
- Suspected waste composition, including concentrations (i.e, D008)
- Number and volume of samples taken
- Purpose of sampling (i.e. contract number, closure activities)
- Description of sampling point and sampling methodology
- Date and time of collection
- Collector's sample identification number
- Sample distribution and how transported (i.e. name of laboratory, UPS, Federal Express)
- References, such as maps or photographs, of the sampling site
- Field observations
- Any field measurements made (i.e. pH, conductivity)
- Signatures of personnel responsible for observations

3.9.7 Chain of Custody Record

A chain-of-custody record will accompany every sample. The record should contain the following information:

- Sample number
- Signature of collector
- Date and time of collection
- Place and address of collection
- Waste type
- Signature of persons involved in the chain of possession
- Inclusive dates of possession

3.9.8 Photographs

Documentation of a photograph is crucial to its validity as a representation of an existing situation. Therefore, the following information regarding photographs will be recorded in the Field Logbook:

- Date, time, location of photograph
- Photographer
- Weather conditions
- Reasons why photograph was taken
- Sequential number of photograph and the film role number
- Camera lens system used

Once the photographs have been developed, this information will be recorded on the back of the photograph.

Photographs cannot be readily taken without the permission of Radford Army Ammunition Plant's Commanding Officer. Thus, prior to closure activities, a request will be made to the Commanding Officer asking for permission to photograph the closure activities.

3.9.9 Sample Analysis Request Sheet

A sample analysis request sheet will accompany the sample on delivery to the laboratory. The person who collects the sample will complete the field portion of the form. All pertinent information recorded in the field logbook will also be included on the sample analysis request sheet. The laboratory portion of the form will be completed by laboratory personnel. The following minimal information will be recorded:

- Name of person receiving the sample
- Laboratory sample number
- Date and time of sample receipt
- Sample allocation
- Analyses to be performed

All samples will be delivered to the laboratory as soon as practicable (usually within 1 or 2 days after sampling and samples must always be kept at 4°C). The sample will be accompanied by a chain-of-custody record and also by a sample analysis request sheet. The sample will be delivered to the laboratory personnel who is authorized to receive samples.

3.9.10 Sample Designation

Sampling locations at the pond will be marked with stakes and surveyed to determine the coordinate and elevation where possible. Once the stake is marked and in place, the area will be photographed. The stake will be marked with the appropriate station and/or sample number.

Samples collected from each location, other than those collected for on-site field measurements or analyses, will be identified by using a standard label which is attached to the sample container.

3.9.11 Sample Handling, Packaging, and Shipping (VHWMR § 3.1.D.2)

For sampling packing and shipping, Radford Army Ammunition Plant will comply with the U.S. Postal Service Regulations, Department of Transportation Regulations and/or the Virginia Regulations Governing Transportation of Hazardous Materials.

3.10 Data Reporting

During the Incinerator Spray Pond Closure, the following data reporting will be conducted:

- Background soil sampling results along with the QA/QC documentation required by Chapter 1 of SW-846 will be submitted to the VDEQ prior to performing statistical comparisons for approval of background soil sample locations.
- Upon completion of the sub-soil assessment sampling, the data will be tabulated and the required statistical comparisons performed. The results will be submitted to the VDEQ for review. Based on the results, either:
  - Clean closure will be achieved and the corresponding closure certification report will be prepared and submitted to the VDEQ.
  - Additional soil removal efforts will be conducted in an attempt to achieve clean closure.
  - Contingent closure and post closure will be implemented as detailed in this plan.

3.11 Groundwater Closure

Groundwater will be monitored in accordance with the Groundwater Monitoring Plan (as updated) until:

- "Clean" closure for both saturated soils (groundwater) and unsaturated soils (the incinerator spray pond subsoils) have been demonstrated; or,
- A post-closure care permit for the cap maintenance and/or groundwater monitoring requirements is obtained.

The specific procedures and criteria for determining "clean" closure with respect to groundwater are as follows:

- For all monitoring wells, initial background concentrations of all designated monitoring parameters will be established based on quarterly sampling for 1 year.
- For each parameter on the "clean" closure list, the arithmetic mean and variance for each well monitored will be calculated. As soon as five quarters of data have been obtained, the fifth quarter results will be compared with the upgradient well's initial background arithmetic mean

and each well's own initial background arithmetic mean. The comparison will consider each of the wells individually in the monitoring system.

- According to the VHWMR (§ 9.5.D.2), the statistical procedure utilized for the comparative purposes will consist of the Student's t-test at the 0.01 level of significance.

After the fifth quarter statistical comparison is performed, the following scenarios are possible:

- If "clean" closure with respect to both the soil and groundwater is achieved, then no further groundwater monitoring will be required.
- If the soils are determined "clean" closed and the groundwater is not "clean" closed, then the groundwater will have been determined to have been contaminated. Therefore, quarterly sampling of the groundwater will be required, pursuant to the VHWMR § 9.5.D, during the post-closure care period.
- If the soils are not clean closed and the groundwater is determined to be clean closed, then at least semiannually monitoring of the groundwater will be required pursuant to the VHWMR § 9.5.C, during the post-closure care period. In addition, a final cover system will be placed over the area to address non-clean closure of soils.

After five quarters, the frequency of groundwater sampling and analysis (if required) will be determined by the VDEQ based on the closure scenarios noted above.

These procedures/criteria should also be contained in the groundwater monitoring plan for the incinerator spray pond closure. (The reader is referred to the separate Groundwater Monitoring Plan document for further details on the groundwater monitoring system and sampling/analytical protocols.

3.12 Certification of Closure (VHWMR Section 10.6.F)

Radford Army Ammunition Plant will provide for an independent Professional Engineer in the Commonwealth of Virginia to verify that the Incinerator Spray Pond was closed in accordance with this closure plan. The independent engineer will be present during all closure activities. The independent engineer's certification will include all documentation such as daily reports, test results, observations, photographs, etc. which demonstrate that the closure was completed in accordance with this approved plan.

The certification of closure will be submitted, by registered mail, to the Director of the Commonwealth of Virginia's Department of Environmental Quality. The certification will be submitted within 60 days of the completion of final closure. The certification will be signed by both the independent Professional Engineer and the responsible official for Radford Army Ammunition Plant.

3.13 Closure Schedule (VHWMR Section 10.6.C.2.f)

VHWMR 10.6.D.1 requires that the closure activities be implemented within 90 days of formal approval of this closure plan by the Commonwealth of Virginia. The regulations require that the final closure of a hazardous waste unit be completed within 180 days of receipt of the Commonwealth of Virginia's written notice of approval (VHWMR Section 10.6.D.2). The regulations also state that an extension to the closure process may be approved by the Commonwealth of Virginia if the final closure activities will take longer than 180 days (VHWMR Section 10.6.D.2.a(1)). Table 3-5 shoes the closure schedule during the clean closure attempt.

TABLE 3-5 CLOSURE SCHEDULE

Activity	Day
Closure Plan Approved	0
Army Cost estimate, Scope of Work, Legal Review, Obtain Funding	0-45
Submit Background Sampling Locations to VDEQ for approval	10
(DEQ response 7 days)	17
Sample Background/ Calculate Background Critical Value/ Submit Results to VDEQ for approval of	25
background (DEQ response 7 days)	32
Remove and Decontaminate Piping, Pumps, Concrete	60
Take Soil Samples in Subsoil Assessment	90
Receive Lab Analyses/ Statistical Analysis and Submit to VDEQ	100
Remove contaminated soil/ resample/ or contingent close	110
Receive Lab Analyses/ Statistical Analysis and Submit to VDEQ	120
Submit Monthly QA/QC Reports as Work Continues	130
Remove contaminated soil/ resample/ or contingent close	140
Repeat Sampling and Excavation as Necessary to "Clean" Close or submit a letter to VDEQ and go to Contingent Closure Plan	150
Equipment Decontamination	
Receive Lab Analyses of Pre- and Post- Rinses	160
Submit Final Report of QA/QC on Work Performed	170
	180
Letter submitted for Certification of Closure Submitted or Contingent Closure	180

Please see the contingent closure plan's contingent closure schedule for estimates of construction times for the cap, etc.

3.14 Clean Closure Excavation Filling

Once any contamination has been removed, the excavation will be back-filled with clean soils, graded to promote positive drainage, and re-vegetated.

4.0 CONTINGENT CLOSURE PLAN

4.1 Introduction

In the event that all contaminated soils cannot be practically removed, Radford will notify the Virginia Department of Environmental Quality, Waste Division and begin implementation of the following contingent closure plan and the contingent post-closure plan.

Knowledge of the incinerator spray pond's dimensions, plus knowledge gained from attempting clean closure will be utilized in determining the area and boundaries of the landfill. The entire open area will be covered by the RCRA cap. If, during cap construction, additional information becomes available, cap coverage will be extended or reduced accordingly. All changes to the cap boundaries will be fully documented.

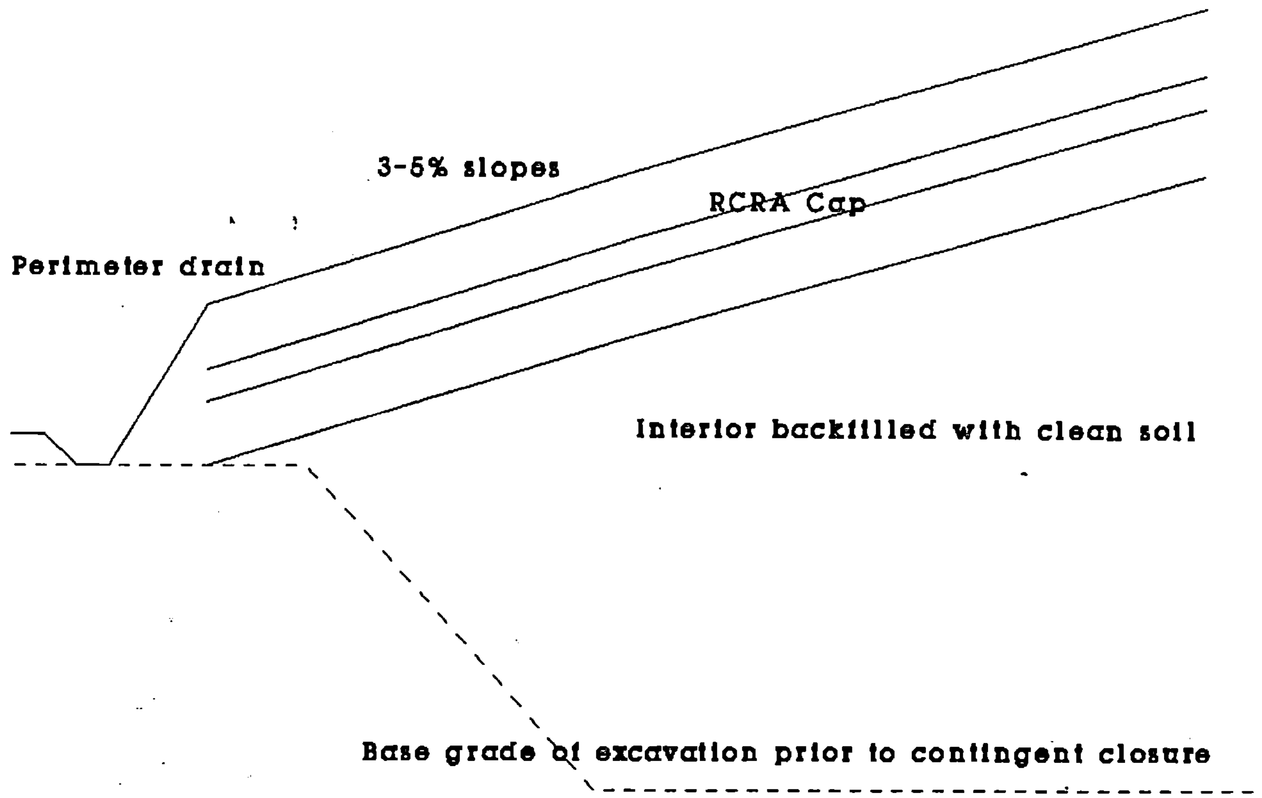
4.2 VHWMR Contingent Closure Plan Requirements (VHWMR Sections 10.10.I.1.b and 10.10.I.3.a(1))

Contingent closure plan requirements are outlined in VHWMR Section 10.10.I.1.b. These requirements consist of three main elements: (1) elimination of free liquids; (2) stabilization of remaining wastes to a bearing capacity sufficient to support a final cover; and (3) construction of a final cover designed and constructed to:

- Provide long-term minimization of the migration of liquids through the closed pond;
- Function with minimum maintenance;
- Promote drainage and minimize erosion or abrasion;
- Accommodate settling and subsidence so that the cover's integrity is maintained; and
- Have a permeability less than or equal to the permeability of any native subsoils present.

4.3 Contingent Closure Implementation

All free liquid will be removed. Any sludge, the concrete layer, associated drains and piping and bedding materials will be removed. Contaminated subsoils will then be removed as practicality dictates and as detailed in this plan. A final cover will then be installed if clean closure is no longer to be attempted.



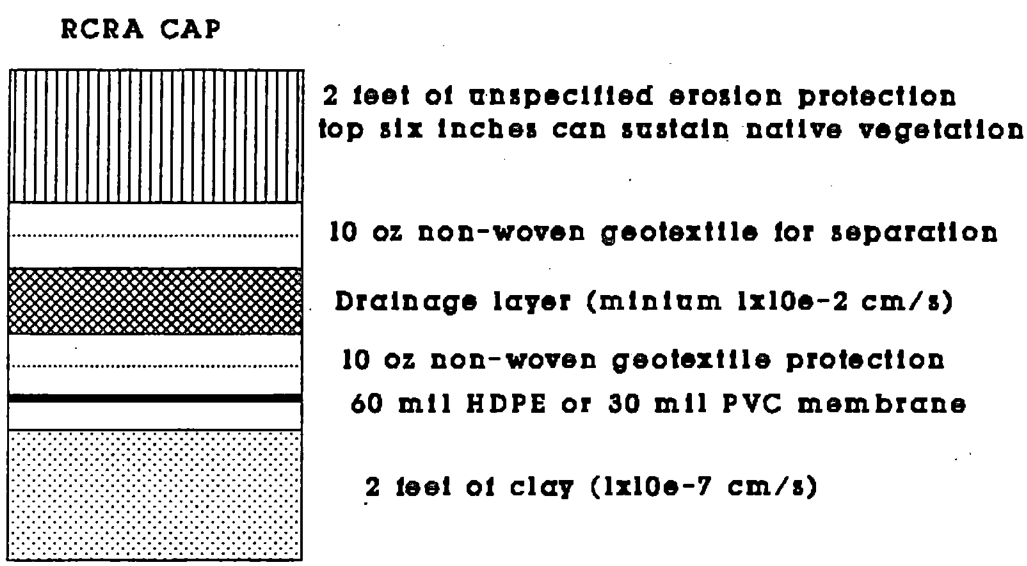


FIGURE 4-1 RCRA 2-1-2 CAP

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4 Final Cover Design

typical schematic of the multi-layer RCRA cover is illustrated in Figure 4-1. The cover will contain ree layers. From the surface down these are: a top layer consisting of vegetation and soil; a soil ainage layer, and a low-permeability bottom layer. The design requirements for each layer are scussed below.

4.1 Plans and Discussion

vailable information from previous closure activities will determine the boundary of the landfill. All ianges to the area capped will be documented with photographs and surveyed so the final as-built awings are accurate. Photographs also will be taken to document each stage of cap construction. An dependent, professional engineer registered in the Commonwealth of Virginia will be on-site during all p truction activities to ensure that the cover system is constructed in accordance with this closure an. The Quality Control/Quality Assurance (QA/QC) Plan discussed this document will be followed iring cap construction; the contractor's quality control officer (CQCO) will maintain complete QA/QC cords as outlined.

4.2 Specifications

ie construction specifications for this closure plan are to be provided in a report, *Specifications for cir--ator Spray Pond Closure*, once it is decided that clean closure will no longer be attempted and ib. ed to VDEQ from Radford. In the case of conflicting information between the construction ecifications and the closure plan, the closure plan will take precedence. Radford Army Ammunition ant will develop final construction drawings and specifications for the incinerator spray pond final ver. These construction drawings and specifications will meet the design requirements detailed herein. ls adford will finalize the Construction Quality Assurance (CQA) plan for the final cover system.

he following sections, at a minimum, will be included in the construction specifications:

- General Paragraphs
- Clearing and Grubbing
- Excavation
- Filling
- Clay Cap Placement
- FML Cap
- Geofabrics
- Drainage Layer Construction
- Erosion Layer Construction
- Erosion and Sediment Control

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4.4.5 Settlement Potential

Since all the waste materials and containment structures will be removed from the incinerator spray pond prior to placement of the cover, the foundation material beneath the cover will be predominately native soil or compacted soil fill. Installation of the cap will not introduce loading rates on the foundation in excess of those historically observed. For these reasons, the potential for further settlement, consolidation, or creep of these foundation materials is minimal. Each soil layer of the cover is compacted as it is placed and it is therefore not anticipated that objectionable settlement of the cap will occur. Settlement is not anticipated in the final cover and thus the ability of the cap to minimize infiltration should not be compromised.

The average depth of frost penetration in the Radford area is 15 inches (EPA). The top layer (the soil and root zone layer) will be constructed at a thickness of 24 inches. Frost penetration will only extend into the top layer of the cover and not to the low permeability compacted clay layer. Frost will not adversely affect the cover performance.

4.4.6 Bearing Capacity and Stability

The existing area is judged to have sufficient bearing capacity for the cap system. The HDPE cap material was selected for its flexibility and durability in the event settlement does occur. Preparation and placement of a protective bedding layer is required to cushion and support the FMC. The compacted subgrade and protective bedding layer will support the FMC and protect it from irregularities in the foundation soil during the post-closure period. The bedding layer for this RCRA cap is the uppermost lift of the clay layer. This bedding material will be free of rock, fractured stone, debris, cobbles, rubbish, and roots. The surface of this layer will be fine-finished with a vibrating roller prior to placement of the FMC.

A 10-ounce, non-woven polypropylene geotextile filter fabric with a puncture resistance of at least 600 N will cover the FMC and prevent penetrations from angular stones in the drainage layer. Calculation 2 demonstrates that the puncture resistance of the geotextile is sufficient to resist puncture from the drainage layer.

The upper bedding layer will be placed soon after installation, seaming, and seam testing of the FMC. As sections of the FMC are approved by the CQCO and Radford representative, placement of the drainage layer will begin. No vehicles will be allowed to drive directly on the FMC. The geotextile and drainage layer stone will be placed on the FMC with the drainage stone spread to its full depth before vehicles are driven on the FMC. The drainage stone layer will be used as a bridge for equipment movement on the FMC. The drainage stone will be placed at the base of the slopes and pushed up the slopes to minimize damage to the underlying geotextile and FMC. Equipment used in construction of the cap will be limited to 6 psi or less ground contact pressure. Materials will be placed on the liner using only rubber tired or tracked vehicles.

As sections of the drainage layer are completed, the second geotextile fabric filter will be placed followed by the 18-inch erosion and 6-inch topsoil layers.

The QA/QC Plan discusses inspections, monitoring, and testing needed to ensure the foundation is properly installed to support the FMC.

4.4.7 Cap System

The cap will be constructed and closure will proceed as follows:

- The site will be cleared and grubbed (as necessary) to ensure adhesion between the existing soil and the cap system. Backfill will be placed to establish the slopes for the cap system.
- No gas vents will be required due to the nature of the waste.
- A 2-foot thick low-permeability clay barrier with an in-place saturated hydraulic conductivity of no more than 1×10^{-7} cm/sec will be constructed over the cap foundation to provide a base for the flexible geomembrane liner and minimize liquid infiltration should the geomembrane fail.
- A geomembrane liner will be placed on the clay layer to prevent infiltration of precipitation through the cover and into the underlying waste. The geomembrane cap will provide maximum flexibility to conform with any settlement which may occur. The liner will be textured to provide added stability to the side slopes and allow increased friction necessary for support of the drainage media. The liner will have enough tensile strength and durability to withstand the applied force of the topsoil layer for the duration of the closure and post-closure periods without breakdown or reduced ability to perform as designed.
- A 10-ounce per square yard non-woven geotextile fabric filter, designed to protect the FMC from puncture by the overlying drainage layer, will serve as the upper bedding layer for the FMC. The synthetic filter material will be non-woven polypropylene mat with sufficient tensile strength and durability to withstand the applied force of the drainage and soil layers for the duration of the closure and post-closure periods without breakdown or a reduction in its ability to perform as designed.
- A 12-inch drainage layer of VDOT No. 8 clean crushed stone (containing no calcium carbonate) with a minimum permeability of at least 1.1 cm/sec will be placed on the geotextile. This layer is designed to remove surface water which infiltrates the top layer and maintain a head of less than 12 inches on the FMC.

geotextile filter layer designed to allow surface water infiltration and separate the overlying soil layer from the underlying drainage layer will be placed over the drainage layer. The filter layer will be an 10 oz/sy non-woven geotextile fabric filter designed to prevent clogging of the drainage layer. The synthetic filter material will be non-woven polypropylene mat with a minimum permittivity of 0.8/sec and tensile strength and durability to perform as designed throughout closure and post-closure.

An 18-inch erosion layer of common fill will be placed over the geotextile filter fabric and drainage layer. A 6-inch layer of topsoil capable of sustaining vegetation will be placed over the erosion layer. These soil layers will protect underlying layers from mechanical and frost damage. The entire area will be seeded to stabilize the soil and prevent erosion. Seed will be applied at a rate of 200 lbs/acre in the following percentages:

Kentucky 31 on Turf Type Tall Fescue	95-100%
Kentucky Bluegrass	0-5%

:tilizer (10-20-10) will be applied at 28 lbs/1000 square feet (sf) and lime (pulverized agricultural grade ıestone) will be applied at 90 lbs/1000 sf. All seeding operations will be conducted in accordance with *Virginia Sediment and Erosion Control Handbook*, Third Edition (1992).

ł.6 ⌣lay Liner

2-foot thick low-permeability clay barrier will be constructed over the cap foundation to provide a base the flexible geomembrane liner and to reduce liquid infiltration should the geomembrane fail. The ıy soil used in the liner will be free of rock, clods, and soil, debris with a minimum of 20% fines (20% ssir he No. 200 sieve), maximum of 10% retained on the No. 4 sieve, plasticity index between 10 ıd 35 percent, and maximum in-place permeability of 1 X 10^{-7} cm/sec. The layer will be placed in 6-ıch lifts and compacted to 95% of its maximum dry density and within 2 to 4 percent wet of optimum ıoisture content as determined in the Standard Proctor test (ASTM Method D-698). In-place hydraulic onductivity will be measured using the two-stage borehole method.

the water content of the clay borrow is less than specified during the design, water will added by raying from a truck or large hose before the clay is compacted. Adequate curing time must be allowed. the clay is too wet, it will be allowed to dry before compaction. Efforts will be made to reduce clod ze during excavation and placement to achieve the required permeability. The clay will be compacted ing equipment such as sheepsfoot rollers to achieve the required compaction/permeability and bonding :tween lifts. The surface of each lift will be scarified so there will be an adequate bond with the lift ›ove it. The edges of the lifts will be beveled or overlapped to ensure complete coverage. The final

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The Quality Assurance tests specified in the following tables will be performed on material proposed for liner construction at the specified frequencies and whenever a change in material occurs. Tables 4-1 and 4-2 delineate the quality controls for construction of the two foot thick relatively impermeable clay cap.

TABLE 4-1 CLAY BORROW SOURCE TESTING

Factor to be Inspected	CQA Inspection Method/Test	Sampling Frequency
Grain Size Analysis	ASTM D-422 and ASTM D-1140	1 per 1000 CY
Moisture Content	ASTM D-2216	1 per 1000 CY
Specific Gravity	ASTM D-854	1 per 5000 CY
Soils Classification	ASTM D-2487	1 per 5000 CY
Atterburg Limits	ASTM D-4318	1 per 5000 CY
Moisture Density Curve	D-698, D-1557, and/or reduced proctor (15 blows per inch)	1 per borrow source
Lab Permeability	ASTM D-5084	1 per 10,000 CY

TABLE 4-2 TESTING METHODS AND FREQUENCIES DURING CONSTRUCTION OF THE LINER

Factor to be Inspected	CQA Inspection Method	Sampling Frequency
Clay Layer Thickness	Observation and Field Measurement	5/lift
Moisture Content	ASTM D-3017, D-4643, D-4944, or D-4959 calibrated against ASTM D-2216	5/lift
Density	ASTM D-2922 or D-2937 calibrated against ASTM D-1556 or D-2167	5/lift
Classification	ASTM D-2487	1/lift
Atterburg Limits	ASTM D-4318	1/lift
In-situ Permeability	Two-Stage Borehole Test, ASTM Draft Test Method	3
Lab Permeability	ASTM D-5084	3/lift

The moisture/density relationship to control actual field placement of the clay cap will be established using a laboratory procedure. The coefficient of permeability relative to minimum compaction will be determined in the laboratory as follows:

- A sample of the selected material which will be used to construct the clay cap will be taken to the laboratory.

ndard moisture-density curve will be developed to determine optimum moisture content and maximum dry density of the compacted soil in accordance with the Standard Proctor Test, ASTM D698.

A sample will be compacted at or above optimum moisture content to a density of not less than 90% of the maximum dry density.

Permeability tests will be conducted in accordance with ASTM D 5084 to determine the coefficient of permeability (k).. If k is less than $1x10^{-7}$ cm/sec., the soil will be placed in accordance with the permitted plans at a density of not less than 90% of the maximum dry density (as determined in ASTM D698). If k is greater than $1x10^{-7}$ cm/sec, the soil will either be considered to be unsuitable and another source(s) will be located and tested, until the permeability requirement is met, or a series of tests varying moisture content and density will be ducted to determine an alternate moisture or density standard which conforms to the specified maximum permeability.

3 Clay Cap Construction

clay fill material will be applied such that the lift thickness (after compaction) will be no greater inches. Thinner lifts are permissible. Prior to compaction, each lift of select clay fill material thoroughly diced to provide soil particle sizes less than 4 inches in diameter. Equipment or truck on the surface will not be permitted during the period between scarifying and placement of the ft. In order to ensure that the clay liner becomes one continuous mass of clay from bottom of the liner, the surface of each lift must be maintained at the specified moisture content and it be scarified (lightly chopped with a disc), not smooth, when covered by the succeeding lift.

sc ying of the underlying lift, representative samples of the new lift will be taken and tested for ture content prior to any compactive efforts. If the moisture content is within the specified range e determined by laboratory testing of borrow source), compaction may begin. If the moisture ent is outside of this range, the select clay fill will be wetted or dried and reworked accordingly. The t fill should be sprinkled or sprayed with water (most probably from a water truck) and dozed, wind-l, and/or disc-plowed to uniformly increase moisture content of the clay if the material is below the um moisture content. The select clay fill should be dozed, wind-rowed, and/or disc-plowed to help y the clay if the moisture content is too high.

lift will be thoroughly compacted and satisfy moisture and density controls through field testing e a subsequent lift is placed. Compaction of lifts will be conducted as follows:

After completion of a segment of compacted clay cap, but before installation of the subsequent layers of the cap. The top of the clay will be surveyed to ensure that: (a) the specified thickness of compacted clay liner has been achieved; (b) the top of the clay liner slopes across the cell at the grades specified on the permitted plans.

4.4.9 Flexible Membrane Cap

4.4.9.1 Materials Specification

The geomembrane will be constructed of 60-mil HDPE, 30 mil VLDPE, or 30 mil PVC. Raw polymer specifications and manufactured sheet specifications for the HDPE membrane are as follows:

HDPE	TEST METHOD	VALUE
Gauge	---	60 mils
Density	ASTM D1505	0.94
Melt Flow Index (g/10 min.) (max)	ASTM D1238 Condition E (190°C, 2.16 kg.)	0.5
Minimum Tensile Properties	ASTM D 638 Type IV (Dumbbell at 2 ipm)	
1. Tensile at Break (lbs/inch width)		216
2. Tensile at yield (lbs/inch width)		126
3. Elongation at Break (%)		630
4. Elongation at Yield (%)		12
5. Modulus of Elasticity	ASTM D882	1.1
Tear Resistance	ASTM D1004	41
Low Temp Brittleness	ASTM D746	-112
Dimensional Stability	ASTM D1203	-2
Carbon black content	ASTM D-1603	2%

These specifications may be superseded by more stringent specifications of the manufacturer. Radford will submit the exact type of membrane proposed for use and the manufacturer's product specifications.

4.4.9.2 Differential Settlement in the Foundation Soils

Due to the small area to be capped and minimal depth of backfill soil the differential settlement effects are negligible. During clearing and grubbing operations and placement of soil fill to establish the final grade for cap placement compaction will occur. Settlement resulting in foundation compression and soil liner compression will be minimal. There is no solid waste in place like landfills to biodegrade and cause settlement or gas production.

4.4.9.3 Strain Requirements at the Anchor Trench

The membrane and geotextile will be anchored in a trench at the toe of the cap. In the case of the membrane, the anchor trench does not affect the potential for sliding because it is at the toe rather than at the top of the slope. For these reasons, calculation of strain requirements of the anchor trench is not applicable.

overlying geotextile. These friction angles are more than adequate for use on a small relatively "flat" cap design for an impoundment closure.

4.4.9.8 Best Anchorage Configuration for the FMC

The anchorage of the membrane is not a design issue. The liner will be anchored in a one-foot wide, two-foot deep trench located at the edge of the cap system around the perimeter of the "landfill." This is a typical anchoring method shown in EPA guidance documents.

4.4.9.9 Soil Cover Stability on Top of FMC

Stability of cover soil is an important concern in designing a landfill cap. However, due to the small size, and relatively flat slopes, sliding instability is negligible. A geotextile will be placed between the flexible membrane and the drainage layer to provide reinforcing and increase friction. Another layer of geotextile will be provided between the drainage layer and the soil erosion protection layer. Calculations show that the erosion layer will be stable, and universal soil loss is much less than 2 for 5% slopes, less than 100 feet of slopes, and a moderate stand of grass.

4.4.9.10 Installation

The earthwork contractor will be responsible for preparing and maintaining the subgrade in a condition suitable for liner installation. The clay liner subgrade will be smooth and firm. Sharp stones, gravel, debris, or any other objects which could penetrate the liner will be removed. Any ruts caused by the compaction equipment or the geomembrane placement equipment will be leveled. The subgrade will be visually inspected prior to installation of the membrane.

The membrane will be delivered to the site on rolls, stored off the ground in small stacks, and protected with a covering or stored in a temporary storage shelter. The storage space will be protected from theft, vandalism, and passage of vehicles. Geosynthetics will be handled in a manner to prevent physical damage, contamination, and exposure.

Before moving a roll from the storage site, an anchor trench 2-feet and 1-foot wide will be completed. Slightly rounded corners will be provided where the geomembrane adjoins the trench to avoid sharp bends in the geomembrane.

The construction contractor will submit a geomembrane layout plan to the owner and CQCO for approval prior to placing the membrane. The membrane will be installed during dry, moderately warm weather to minimize the effects of thermal expansion and contraction. The manufacturer's instructions will be followed for liner placement and seam overlap. The method used to unroll the panels will not cause scratches or crimps in the geomembrane. Sandbags will be placed along the edges of the geomembrane to prevent uplift pressures of up to 37 psf and the resulting wind damage. Field panels will be placed one at a time in a manner which minimizes wrinkles.

The panels will be seamed immediately after placement following the manufacturer's recommended seeming procedures. The ambient temperature should be above 5° F during seaming. Surfaces to be seamed will be clean and dry when the seams are made. Seams will be oriented parallel to the line of maximum slope. All field seams will be non-destructive tested in accordance with ASTM D 4437 seam evaluation using the vacuum box technique. Destructive tests will be performed on test specimens in accordance with ASTM D-413 and ASTM D-638 for peel and shear of geomembrane seams. One sample will be taken for destructive testing every 500 linear feet of weld.

The liner will be covered within the time limits specified by the manufacturer. The geotextile fabric will be placed on the geomembrane as soon as possible after approval of the geomembrane placement. The stone drainage layer will be placed on the geotextile using equipment which will either not need to move on to the cap area or rubbered tired equipment. Vehicles will be driven only on the full depth stone drainage layer or subsequent soil cover. Vehicles will not be allowed to drive directly on the geomembrane or geotextile layers.

QA/QC procedures to be followed during cap installation, including inspections, material certifications, and testing will be discussed in Section 7 of this document.

4.4.10 Filter Layer

The design properties of concern for the geotextile filter layer above the drainage layer are permittivity and clogging potential. The minimum permittivity required for the geotextile is 6.0×10^{-3} /sec. The permittivity of the geotextile specified in the design is 0.08/sec, well above the minimum. Therefore, the geotextile will easily allow surface water to flow through it to the drainage layer.

The potential for the geotextile to clog must be evaluated using site specific cover soil and recommended geotextile. The suggested test is the U.S. Army Corps of Engineers Gradient Ratio Test CW-02215 with the gradient ratio calculated value less than 3. The chosen geotextile must have an apparent opening size (O_{95}) meeting the following specifications:

$$O_{95}/D_{85} < 2.0$$
$$O_{95}/D_{15} > 2.0$$

Clogging potential will be determined by the contractor after the source of the backfill is selected and the specific geotextile is chosen.

The geotextile filter located above the FMC is designed as a protective layer and permittivity of this geotextile is not a concern.

4.4.11 Drainage Layer

The drainage layer is required to reduce the head of water on the soil barrier layer and also to prevent water backup into the vegetative layer. The minimum thickness of the middle drainage layer will be 12 inches. The saturated hydraulic conductivity of the drainage materials will not be less than $1x10^{-2}$ cm/sec at the time of installation.

The upper portion of the drainage layer will be designed to prevent clogging, and will be overlain by a synthetic fabric filter or graded granular material. The upper slope will be at least 3-5 percent after allowance has been made for settling and subsidence, and will be overlain by granular materials such as sand. The granular material will be no coarser than 3/8 inch and classified as SP. The material will be crushed and angular with no debris that may damage the underlying flexible membrane liner, or fines that may lessen permeability, or dissolvable minerals such as lime.

Discharge from the drainage layer will flow freely so that fluid does not back up into the vegetative layer during a major sustained storm event. The drainage layer will be sloped to an exit drain which will allow the percolated water to drain.

4.4.12 Vegetative Layer

The top layer is required to retain soil moisture, minimize root penetration into the barrier layer, and provide greater tolerance to the adverse impact of erosion. The top layer will have a thickness of no less than 24 inches, of which a minimum of the top six inches will be topsoil and will contain sufficient nutrients necessary for the growth and sustenance of a vegetative cover.

The entire area will be seeded to stabilize the soil and prevent erosion. Seed will be applied at a rate of 200 lbs/acre in the following percentages:

Kentucky 31 on Turf Type Tall Fescue	95-100%
Kentucky Bluegrass	0-5%

Fertilizer (10-20-10) will be applied at 28 lbs/1000 square feet (sf) and lime (pulverized agricultural grade limestone) will be applied at 90 lbs/1000 sf. All seeding operations will be conducted in accordance with the *Virginia Sediment and Erosion Control Handbook*, Third Edition (1992). Cover vegetation should be drought resistant, persistent, erosion resistant and adapted to local conditions.

The surface drainage system will be capable of efficiently conducting runoff across the cap. The drainage ditches will be adequate to accommodate the runoff from a 24-hour, 25-year storm.

4.4.13 Drainage Evaluation

In order to limit runoff infiltration and to limit erosive velocities from runoff on the impoundment surface it is recommended that a uniform 3-5% grade be incorporated into the design of the final cover. One of the most effective ways to minimize surface water infiltration through the final cover is to divert runoff away from the closed structure. Since the site will be graded for positive drainage, and based on existing site topography, positive drainage will be maintained away from the site. Run-on from an off site source is not expected due to site specific conditions.

4.4.14 Survey Control

The following procedures will be followed with respect to the survey of the completed clay cap:

- The completed clay surface will be surveyed, before the placement of subsequent cover layers, to verify that grades are in accordance with the plans. In addition, a comparison of the pre- and post-clay cap construction surveys will be conducted to verify construction to the permitted thickness.
- A minimum of one cross-section for every 100 linear feet of cell length and width will be surveyed. At a minimum, survey points will be established at the top, mid-point, and bottom of each slope. These survey points will be coincident with those of the previous cross-section lines.
- Acceptable tolerances on survey coordinates will be ± 0.2 feet on elevations and ± 1.0 foot on coordinates. The clay cap will be greater than or equal to the thickness specified.
- The CQA inspection personnel certifying the survey results will be either a Registered Land Surveyor or a Professional Engineer.
- The CQA Officer will certify that the clay cap meets the requirements in the plans and specifications and submit documentation to the Project Manager.

4.5 Construction Quality Assurance Plan

The CQA plan will detail procedures for inspecting the quality of construction materials and the construction practices employed during their placement. The CQA plan will further provide assurance that: (1) the materials for each layer are as specified in the design specifications; (2) each layer is constructed as specified in the plans; and (3) all layers of the final cover are uniform and damage-free. The CQA plan can be found in the appendix.

4.6 Site Access

Access to the Radford Army Ammunition Plant is severely limited due to the on site security required for operations. All vehicles entering the Radford must pass through the main entrance and a second security checkpoint before approaching the site. Existing fences, gates, and vegetation will be utilized to restrict unauthorized access to the waste disposal area. A clearly visible and legible sign will be maintained at the closure area indicating the hazards.

4.7 Engineer's Certification of Contingent Closure (VHWMR Section 10.6.F)

Radford will provide for an independent Professional Engineer in the Commonwealth of Virginia to verify that the Incinerator Spray Pond was closed in accordance with the specifications in this closure plan. The independent engineer will be present during all closure activities. The independent engineer's certification will include all documentation such as daily reports, test results, observations, photographs, etc. which demonstrate that the closure was completed in accordance with the approved plan.

The certification of closure will be submitted, by registered mail, to the Director of the Commonwealth of Virginia's Department of Environmental Quality. The certification will be submitted within 60 days of the completion of final closure. The certification will be signed by both the independent Professional Engineer and the responsible official for Radford Army Ammunition Plant.

4.8 Notification of Type, Quantity and Location of Wastes (VHWMR Section 10.6.J.1)

No later than 60 days after certification of closure of the incinerator spray pons, Radford will submit to the County Board of Supervisors and to the Director of the Commonwealth of Virginia's Department of Environmental Quality a record of the type, location, and quantity of hazardous waste located in the closed incinerator spray pond.

4.9 Survey Plat Submittal (VHWMR Section 10.6.G)

Within 60 days of closure, a survey plat indicating the location and dimensions of the incinerator spray pond closure as a landfill with respect to permanently surveyed benchmarks will be submitted to the local zoning authority and to the Director of the Commonwealth of Virginia's Department of Environmental Quality. The plat will be prepared and certified by a Professional Land Surveyor in the Commonwealth of Virginia. Radford will submit a certification to the Director that a survey plat and record of the type, quantity, and location of the hazardous wastes has been submitted to the local zoning authority.

4.10 Deed Restriction (VHWMR Section 10.6.J.2)

Within 60 days of certification of closure of the pond, Radford will record in accordance with state and local law, a notation on the deed to the facility property, or on some other instrument which is normally examined during title search, that will in perpetuity notify any potential purchaser of the property that:

- The land has been used to manage hazardous wastes; and
- Its use is restricted under VHWMR Section 10.6; and
- The survey plat and record of the type, location, and quantity of hazardous wastes disposed of within each hazardous waste unit required by VHWMR Sections 10.6.G and 10.6.J.1., have been filed with the local government and with the Director of the Commonwealth of Virginia's Department of Environmental Quality.

Radford will submit to the Director a certification stating that the facility has recorded the notation specified in VHWMR Section 10.6.J.2.a. A copy of the document in which the notation has been placed will also be submitted.

4.11 Post Closure Care Permit Application (VHWMR 11.1)

Within 180 days of contingent closure, an application for a post-closure care permit with the applicable permit fee will be submitted to the Virginia Department of Environmental Quality, Waste Division.

12 Contingent Closure Schedule (VHWMR Section 10.6.C.2.f)

The contingent closure schedule for the pond is detailed in Table 4-3.

TABLE 4-3 CONTINGENT CLOSURE SCHEDULE

Activity	Days
If contaminated soils cannot be practically removed, then begin construction of final cover	0
Survey Excavation	0
Backfill with Clean Soils	10
Submit Plan Sheets, Geomembrane Type & Layout, Erosion Control Plan with Support Calculations,	20
and Specifications	60
Begin Construction of Cap	
clay	90
geomembrane	100
geotextile	110
drainage layer	120
geotextile	130
soil	140
topsoil spread	150
topsoil seeded and erosion controls placed	160
Submit Monthly QA/QC Reports	170
Submit Final Report of QA/QC on Work Performed	180
Submit Certification of Closure	
Within 60 Days of Completed Cap Construction Submit: Record of Type, Location, and Quantity of Waste Closed in Place Certification Letter that Survey Plat was Submitted to Local Zoning Authority with copy of Survey Plat Certification Letter that Permanent Notation was made on Property Deed, with Wording Submitted to VDEQ for Approval	180-240
Within 180 Days of Completed Cap Construction Submit: Application for Post Closure Care Appropriate Application Fee	180-360
Upon Completion of the 30 Year Post-Closure Care Period: Within 60 Days of Completion of the Post Closure Care Period Submit a Certification Letter that Post-Closure is Completed	30 years + 60 days

development of a naturally fertile and stable surface environment. Mulching, seeding with native grasses, and fertilizing will be performed as soon as possible after regrading/disking, and in accordance with the recommendations of the local SCS office.

5.5 Maintenance of Groundwater Monitoring Wells

Ground water monitoring wells require regular inspections and maintenance over time in order to maintain them in the originally completed condition. Over extended time periods (one year or longer) monitoring wells should be inspected and maintained for the following potential conditions or problems:

- Aboveground portions of monitoring wells should be inspected for evidence of tampering or actual physical damage each time the well is sampled or checked for static ground water level. At a minimum, an annual physical inspection should be performed.
- At similar intervals, the total depth of monitoring wells should be checked in order to ascertain if there has been excessive sediment influx into the well casing that could potentially clog the well screen.
- During all rounds of pre-sampling well purging, the ground water should be checked for unusually high levels of Ph (10 to 12) which could indicate that the bentonite seal in the well has failed or partially dissolved and washed into the screened portion of the well. Bentonite has been documented to cause high Ph levels when present in well water.
- Other unusual well conditions may warrant using downhole geophysical tools or a downhole camera in order to properly assess deep hole well conditions of both riser casing and well screen.
- Extreme or unexpected water level changes may also be indicators of downhole casing or screen problems. Very low levels may indicate a problem such as screen clogging with sediment or bacterial growth. Unusually high water levels could indicate a bentonite seal or riser casing failure that would allow surface runoff water or water from a different aquifer to be entering the well bore.
- Maintenance should be performed on ground water monitoring wells at least annually, and should consist of surging and purging the well to clear any sediment influx over time and to allow checking for unusual or unexpected well conditions that may have developed since initial well completion.

5.6 Maintenance of Run On and Runoff Control Structures

The Commonwealth of Virginia requires a plan for continued maintenance of storm water management facilities. Where local government does not choose to accept maintenance responsibility the responsible entity is required to accept maintenance responsibility and a maintenance agreement must be entered into with the local government.

In order to guard against the cumulative effects of erosion and storm damage it is important to prepare and follow a maintenance plan for the facility. Inspections will be conducted as indicated in the inspection reports in the appendix. Maintenance will be conducted as indicated below.

- The cap surface, adjacent swales, storm water management area will be inspected quarterly and after major storm events.
- Berms shall be specifically inspected for evidence of slope failure, erosion and overall integrity.
- Evidence of erosion, outlet structure blockage, vegetation over-growth, and other features which may effect the function of the drainage system for the facility shall be noted.
- After an inspection is conducted, if required, areas of erosion shall be filled and seeded with appropriate cover vegetation, swales and berms shall be inspected by qualified personnel and assessments of the integrity of the structures made, the storm water management pond outlet structure including outlet structure, orifice and outlet culvert shall be cleaned of all extraneous debris, trash, sediment and vegetation.

5.7 Benchmark Integrity

Numerous USGS benchmarks are located at Radford Army Ammunition Plant. All survey work will be conducted using at least one of these benchmarks. Due to the controlled nature of RAAP, the benchmarks should be secure.

5.8 Post-Closure Inspection Log [VHWMR Section 10.6.H.1.a.(2)]

The Post-Closure Inspection Log form is included in the Appendices. This form will be utilized to guide and document the above-described inspection activities.

5.9 Recordkeeping/Contact Persons

The post-closure care plan and records (i.e. inspection logs) will be maintained at the facility. The plan and records will be available for review by the Commonwealth of Virginia's Department of Environmental Quality. The Radford Army Ammunition Plant representative to contact about post-closure care will be: Mr. Joe D. Wilson, Chief Engineer, US Department of the Army, Radford Army Ammunition Plant, Caller Service 2, Radford, Virginia 24141-0298. Information about this report can also be obtained from Mr. Robert L. Richardson at (703) 639-8641, or Jerome J. Redder, P.E. at (703) 639-7536.

5.10 Certification of Completion of Post-Closure Care (VHWMR 10.6.K)

No later than 60 days after completion of the established post-closure care period, Radford Army Ammunition Plant will submit to the Commonwealth of Virginia's Department of Environmental Quality Director, by registered mail, a certification that the post-closure care period for the incinerator spray pond was performed in accordance with the specifications in this approved post-closure plan. The certification will be signed by the official representative for Radford and an independent Professional Engineer regestered in the Commonwealth of Virginia.